TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

2014 On-Road Mobile Source Annual, Summer Weekday and Winter Workday Emissions Inventories: San Antonio Area

Prepared by the Texas Transportation Institute

A Member of The Texas A&M University System

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DEVELOPMENT OF 2014 ON-ROAD MOBILE SOURCE ANNUAL, SUMMER WEEKDAY, AND WINTER WORK WEEKDAY EMISSIONS INVENTORIES FOR SPECIFIED AREAS: SAN ANTONIO AREA

TECHNICAL REPORT

FINAL

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Air Quality Planning and Implementation Division

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PURPOSE

This work provided the on-road mobile source portion of the 2014 evaluation year emissions inventories needed for the state of Texas under the Air Emissions Reporting Requirements (AERR) and to support the U.S. Environmental Protection Agency's (EPA) comprehensive three-year cycle National Emissions Inventory (NEI). Annual, summer weekday, and winter work weekday emissions inventory estimates of criteria air pollutants (CAPs), CAP precursors, and hazardous air pollutants (HAPs) were developed. The AERR was published in the Federal Register on December 17, 2008, (Volume 73, Number 243, pp 76539 - 76558). Revisions to the AERR requirements were published in the Federal Register on February 19, 2015 (Volume 80, Number 33, pp 8787 – 8799).

BACKGROUND

The Texas Commission on Environmental Quality (TCEQ) works with local planning districts, the Texas Department of Transportation (TxDOT), and the Texas A&M Transportation Institute (TTI) to provide on-road mobile source emissions inventories of air pollutants. TxDOT typically funds transportation conformity determinations required under 40 Code of Federal Regulations (CFR) Part 93. TCEQ funds mobile source inventory work in support of federal Clean Air Act (CAA) requirements, such as attainment of the National Ambient Air Quality Standards (NAAQS) and the study and control of HAPs, including those from motor vehicles and/or motor vehicle fuels (as mandated under CAA sections 202 and 211).

Under the AERR, states are required to prepare a comprehensive statewide emissions inventory every three years. The next three-year cycle inventory year is 2014 and is due to the EPA by January 15, 2016. This inventory work includes both CAPs and HAPs for on-road mobile sources. The on-road mobile inventories prepared incorporated recently collected data for calendar year 2014 and used the newest EPA emissions factor model, MOVES2014. To meet the January 15, 2016, deadline, TCEQ needs to have on-road mobile emissions inventory development completed by August 2015.

DEVELOPMENT OF 2014 ON-ROAD MOBILE SOURCE ANNUAL, SUMMER WEEKDAY, AND WINTER WORK WEEKDAY EMISSIONS INVENTORIES FOR SPECIFIED AREAS

TTI developed and produced the Texas 2014 on-road mobile source triennial (periodic) emissions inventories that include AERR-required CAPs and CAP precursors as well as the HAPs as specified in the following. TTI developed emissions estimates for AERR-required categories, including summer weekday, winter work weekday, and annual emissions estimates. TTI obtained local 2014 meteorological and fleet characteristic data and processed the information for use as inputs for the development of the inventories.

The seasonal weekday (winter work and summer weekday) emissions estimates for 2014 were developed using the detailed, link-based, time-of-day methodology for which current travel models were available, as listed in Table 1. Other county inventories, also identified in Table 1, were estimated using the Highway Performance Monitoring System (HPMS)-based methodology. In total, 242 of the 254 Texas counties were included in analysis performed by TTI.

EPA requires emissions inventory reporting for the 2014 AERR through the Central Data Exchange (CDX) system. TTI prepared summary files for submittal of the 2014 AERR and HAPs inventories to the CDX consistent with the format requirements of the Consolidated Emissions Reporting Schema (CERS) written in Extensible Markup Language (XML).

TTI produced 2014 AERR CAP and HAP emissions inventories consistent with the following bulleted items, based upon applicable EPA requirements and guidance on development of actual emissions inventories. The methods used to develop these inventories were agreed upon in consultation with the TCEQ Project Manager.

TTI adhered to the following.

- Used the most recent version of the EPA's on-road emissions model, MOVES2014, released October 2014, as the emissions factor model for developing the inventories.
- The geographic scope for the annual and summer weekday emissions was statewide excluding the following 12 counties in the Dallas-Fort Worth (DFW) area: Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise. Used the following geographic scope for winter work weekday emissions: El Paso.
- For the CAPs and CAP precursors, developed and produced inventories for three temporal levels: 1) summer weekday (all counties excluding the 12 counties in the DFW area); 2) winter work weekday (El Paso County only); and 3) annual (calendar year totals for all counties excluding the 12 counties in the DFW area).
- Included the following CAPs and CAP precursors in the inventories produced for this task: volatile organic compounds (VOC), carbon monoxide (CO), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), ammonia (NH_3), carbon dioxide (CO_2), particulate matter with an aerodynamic diameter equal to or less than 2.5 microns ($PM_{2.5}$), and particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM_{10}).
- Used summer weekday and winter work weekday as the day type for the seasonal inventories. Adjusted the average daily activity levels for the activity level difference between average annual and average for summer months or winter months and for weekday.
- For the HAPs, developed and produced annual inventories (all counties excluding the 12 counties in the DFW area).
- Included the following HAPs in the inventories produced for this task: the six priority mobile source air toxics (MSATs) (benzene, methyl tertiary-butyl ether, 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein); the additional on-road mobile source air toxic pollutants included in the MOVES2014 database (gaseous hydrocarbons, metals, dioxin/furans, and polycyclic aromatic hydrocarbons); and all 21 MSATs listed in the EPA's 2001 MSAT rule.

- Used 2014 climate inputs. Used temperature, humidity, barometric pressure, and other data, as agreed upon and provided by TCEQ (TCEQ monitoring operations or national climatic data, for scenario counties or meteorologically similar county groups).
- Used the most current vehicle miles traveled (VMT) mixes. The VMT mixes were consistent with the EPA MOVES source use types.
- Used 2014 data for the off-network activity development. Developed off-network activity inputs based on current Texas on-road inventory development processes and documented the process for development in the pre-analysis plan.
- Used 2014 regional registration data as input for locality-specific age distributions.
- Modeled the effects of the oxygenated fuel program for El Paso.
- Used MOVES individual fuel parameter inputs consistent with CFR Title 40 – Protection of the Environment, Part 80 – Regulation of Fuels and Fuel Additives, Section 27 – Controls and Prohibitions on Gasoline Volatility (40 CFR § 80.27).
- Used the EPA's 2014 reformulated gasoline (RFG) compliance data and the 2014 fuel property survey data, including Reid Vapor Pressure (RVP), to develop model inputs. EPA provided the 2014 Houston-Galveston-Brazoria (HGB) area RFG compliance data and TCEQ provided the 2014 Summer Fuel Field Study Final Report and associated electronic files.
- Modeled the effects of all the federal motor vehicle control programs.
- Modeled RFG for Houston.
- Modeled the Austin-Round Rock, HGB, and El Paso inspection and maintenance (I/M) program areas.
- Modeled federally-regulated gasoline and diesel sulfur levels or latest available fuel survey data, as appropriate.
- VMT by summer and winter work weekday: where available, TTI used travel demand model (TDM) network link-based VMT for counties covered by TDM and used HPMS-based VMT for counties without a TDM.
- Post-processed the diesel vehicle NO_x emissions factors to account for the Texas Low Emissions Diesel (TxLED) program, consistent with 30 Texas Administrative Code (TAC) Sections 114.312-114.319. Used year-specific TxLED adjustment factors developed using the benefit information described in the EPA *Memorandum on Texas Low Emission Diesel Fuel Benefits*, and the method as documented in previous Texas on-road inventory development reports.

TTI provided inventory summaries in an uploadable format compatible with the EPA's Emissions Inventory System (EIS) and TCEQ's Texas Air Emissions Repository (TexAER). The format was based upon the most recent version of the EPA's National Emission Inventory Format, the CERS written in XML. The EPA updated the on-road Source Classification Codes (SCCs) and the EIS uses the new SCCs. The uploadable inventory files were based upon the SCCs that are compatible with the 2014 NEI code list. TTI developed and provided SCC-based inventory files in both CERS XML format and in tab-delimited text file format.

TTI developed and delivered a set of MOVES county database files (CDBs) that include county-specific activity and control program tables sufficient for the CDBs to be used in the MOVES inventory mode and produce results consistent with, though not necessarily identical to, the results produced using MOVES rates output and the TTI post-processing inventory development utility. The activity and fleet characterization tables included: VMT; monthly, day-of-the-week, and hourly VMT distributions; source type populations; and source type age distributions.

TTI provided CDBs in an uploadable format compatible with the EPA's EIS. TTI provided the uploadable-ready CDBs in conjunction with the emissions inventories.

This technical note covers the San Antonio area counties. It is one of seven reports (by geographic area) documenting development of the 2014 AERR on-road mobile source inventories for 242 Texas counties (all Texas counties except for the specified 12 DFW area counties). Table 1 shows these seven areas. This analysis included both summer weekday and annual emissions estimates for VOC, CO, NO_x, NH_3, SO_2, PM_{10}, $PM_{2.5}$, and CO_2; and annual estimates for 70 HAPs including 14 gaseous hydrocarbons, 32 polycyclic aromatic hydrocarbons (16 compounds, estimated in both gaseous and particulate phase components), seven metal compounds, and 17 dioxins and furans. Emissions summaries by the pollutant emissions processes available in MOVES are included.

Table 1. Areas, Counties, and Activity Basis for AERR and Toxics Inventory.

Area[1]	Counties	Activity Basis
1. Houston-Galveston-Brazoria (HGB) Area	Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller	TDM
2. Beaumont-Port Arthur Area	Jefferson, Hardin, Orange	TDM
3. El Paso Area[2]	El Paso	TDM
4. Austin Area	Bastrop, Burnet, Caldwell, Hays, Travis, Williamson	TDM
5. San Antonio Area	Bexar, Comal, Guadalupe, Kendall, Wilson	TDM
6. Northeast Texas Area	Gregg, Smith Harrison, Rusk, Upshur	TDM HPMS
7. Remainder of Texas (less 12 DFW MSA counties)	214 counties	HPMS
Totals by Activity Basis	25 217	TDM HPMS

[1] Areas listed include all Texas counties except for the 12 DFW MSA counties of Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise. The 28 "area" counties listed for (1) through (6) were modeled using county level emissions rates, whereas the remaining 214 counties (7) were modeled using the statewide inventory methodology, which produces emissions rate estimates by county groups.
[2] El Paso is the only county for which a winter weekday inventory was produced.

TTI included the following in the electronic file submission:

- A document listing all the files being submitted and detailing file naming conventions;
- MOVES CDBs, MOVES run spec files, and MySQL files used to process data files for MOVES runs;
- All applicable data relating to task activities;
- Two standard sets of activity and inventory summary files: one based upon MOVES source use types (SUTs) and one based upon the EPA's SCCs;
- TexAER-ready formatted inventory files;
- Inventory files formatted and ready for uploading to the EPA's EIS; and
- CDBs formatted and ready for uploading to the EPA's EIS.

Acknowledgments

Dennis Perkinson, Ph.D., L.D. White, Stacey Schrank, and Martin Boardman, all of TTI, contributed to the development of the AERR MOVES-based inventories and associated data delivered. Metropolitan planning organizations (MPOs) and TxDOT personnel previously provided travel model data sets needed. TCEQ provided meteorological input data. Dr. Perkinson produced the VMT mixes used to divide fleet VMT activity into MOVES SUT by fuel type categories, county VMT control totals, and hourly VMT and other VMT factors. White processed roadway based activity (VMT and speeds) and produced the vehicle population estimates, as well as performed the annual emissions calculations. Boardman produced MOVES model and MOVES output post-processor set-ups, and the MOVES-based seasonal weekday emissions factors with adjustments for TxLED fuel, as well as MOVES emissions rate annualization factors for the annual emissions analysis. Schrank produced the off-network activity estimates and the 24-hour seasonal weekday period emissions run set-ups, and performed the emissions runs. White produced the extra set of MOVES CDBs that may be used with MOVES in inventory mode. Gary Lobaugh, of TTI, was responsible for editing, design, and production of this technical report. Each member of the assigned TTI staff contributed to the quality assurance of the inventory elements. Dr. Perkinson was the principle investigator for this project. This work was performed by TTI under contract to TCEQ. Daniel Perry was the TCEQ project technical manager.

The discussion is organized in the following sections: Summary of Results, Overview of Methodology, Development of Vehicle Type VMT Mix, Estimation of Summer Weekday VMT, Estimation of Link Speeds, Estimation of Summer Weekday Off-Network Activity, Estimation of Summer Weekday Emissions Factors, Summer Weekday Emissions Calculations, Annual Activity and Emissions, Additional CDBs for MOVES Inventory Mode, and Quality Assurance.

SUMMARY OF RESULTS

Table 2, Table 3, and Table 4 summarize the San Antonio five-county area 2014 estimates of summer weekday 24-hour CAPs and CO_2 emissions, annual CAPs and CO_2 emissions, and annual HAPs emissions, respectively. Summer weekday VMT and speeds, and annual VMT estimates are also included. Note that while Table 4 includes separate estimated totals of all six priority MSATs (i.e., benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and diesel particulate matter/diesel exhaust organic gases [DPM + DEOG]) and other individual HAPs or HAPs categories, the DPM +DEOG (estimated as total diesel fleet VOC and PM_{10} exhaust) is not exclusive of the other HAPs listed.

The detailed emissions inventory results in a tab-delimited file formats (by pollutant and emissions process, for each SUT/fuel type and roadway category) were provided in electronic form as Appendix A (see description in Appendix A).

Table 2. San Antonio Area 2014 Ozone Season Weekday Emissions (Tons/Day).

County	VMT	Speed	VOC	CO	NO_x	CO_2	SO_2	NH_3[1]	PM-10[2]	PM-2.5[2]
Bexar	43,946,656	39.4	23.87	269.15	44.92	22,877.46	0.38	1.34	3.11	1.37
Comal	4,651,102	46.0	2.17	26.37	4.80	2,384.91	0.04	0.14	0.29	0.15
Guadalupe	3,940,291	46.9	2.11	24.22	4.93	2,216.32	0.03	0.12	0.28	0.15
Kendall	1,145,903	51.1	0.67	7.15	1.76	694.47	0.01	0.03	0.09	0.05
Wilson	1,335,707	43.9	0.78	8.83	1.63	747.39	0.01	0.04	0.11	0.06
Total	**55,019,659**	**40.6**	**29.61**	**335.71**	**58.04**	**28,920.54**	**0.48**	**1.68**	**3.88**	**1.78**

[1] PM estimates are MOVES-based only (i.e., no re-suspended dust from roadways is included).

Table 3. San Antonio Area 2014 Annual Emissions (Tons/Year).

County	VMT	VOC	CO	NO_x	CO_2	SO_2	NH_3[1]	PM-10[2]	PM-2.5[2]
Bexar	15,515,284,236	8,103.76	88,812.22	16,782.15	7,763,977.01	129.02	473.17	1,099.76	500.70
Comal	1,642,062,813	736.12	8,613.83	1,791.71	807,111.43	13.08	49.36	104.17	53.41
Guadalupe	1,391,112,326	715.15	8,001.87	1,852.81	750,637.45	11.23	42.85	99.68	55.41
Kendall	404,558,899	232.98	2,465.72	663.03	237,088.12	2.99	12.09	30.77	19.08
Wilson	471,568,844	264.62	2,913.69	606.19	251,685.18	3.87	14.34	38.21	20.09
Total	**19,424,587,118**	**10,052.63**	**110,807.32**	**21,695.89**	**9,810,499.20**	**160.19**	**591.80**	**1,372.58**	**648.69**

[1] PM estimates are MOVES-based only (i.e., no re-suspended dust from roadways is included).

Table 4. San Antonio Area 2014 Annual Hazardous Air Pollutant Emissions (Tons/Year).

County	Benz[1]	Form	Acet	1,3-But	Acrol	Other Gas HC	MTBE	Eth	PAH	Metal	Dio/Fur[2]	DPM +DEOG[3]
Bexar	203.82	121.10	95.41	35.50	8.48	1706.99	0.00	515.01	22.97	0.0979	0.00000067	952.80
Comal	18.16	13.11	9.30	3.13	0.91	151.06	0.00	44.73	2.35	0.0105	0.00000007	116.26
Guadalupe	17.75	11.57	8.70	3.09	0.82	148.28	0.00	44.01	2.17	0.0092	0.00000006	109.40
Kendall	5.93	3.92	2.88	0.90	0.28	47.75	0.00	14.71	0.73	0.0028	0.00000002	40.16
Wilson	6.66	4.17	3.18	1.15	0.29	55.05	0.00	16.00	0.80	0.0031	0.00000002	38.02
Total	**252.32**	**153.87**	**119.47**	**43.77**	**10.77**	**2,109.12**	**0.00**	**634.46**	**29.01**	**0.12**	**0.00000083**	**1,256.64**

[1] The HAPs abbreviations are, in order from left to right: Benzene, Formaldehyde, Acetaldehyde, 1.3-Butadiene, Other Gaseous Hydrocarbon HAPs (in addition to the prior five: Toluene, Xylene, 2,2,4-Trimethylpentane, Hexane, Ethyl Benzene, Styrene, Propionaldehyde), Methyl Tertiary Butyl Ether, Ethanol, Polycyclic Aromatic Hydrocarbons (16 PAHs), Metal Compounds (Arsenic, Chromium, Manganese, Mercury, Nickel), Dioxins and Furans (17), and diesel particulate matter and diesel exhaust organic gases (represented as total of diesel fleet exhaust VOC and exhaust PM_{10}).

[2] Dioxins and Furans are calculated in terms of TEQ mass, or “toxic equivalents,” which resolves the emissions of all dioxin and furan congeneres into a single “species” represented by the two most carcinogenic congeneres (2,3,7,8-tetrachlorodibenzo-p-dioxin and 1,2,3,7,8-penatachlorodibenzo-p-dioxin).

[3] Note that the DPM+DEOG emissions estimates are not exclusive of the other tabulated fleetwide HAPs emissions estimates.

OVERVIEW OF METHODOLOGY

TTI used the detailed, hourly, MOVES rates-per-activity, TDM link-based method, which produces hourly emissions estimates by vehicle type (Table 5), pollutant, and emissions process (Table 6) for each county inventory. It is an adaptation of the previous TDM link-based emissions inventory method used with MOBILE6, which applied emissions rates for all emissions processes in terms of miles-traveled activity (e.g., grams/mile [g/mi]).

In addition to the VMT-based calculations of roadway-based emissions estimates, the TTI MOVES emissions inventory process uses off-network activity measures (i.e., starts, source hours parked [SHP], source house idling [SHI], and auxiliary power unit [APU] hours). Associated emissions rates must be produced in these terms for the off-network emissions process calculations. Previous versions of MOVES provided the off-network start, evaporative, and extended idling rates only in "per vehicle" units, not applicable to the TTI activity-based inventory process; TTI post-processing utilities were used to produce the MOVES off-network rates in the needed activity units. One of the changes with MOVES2014, however, was the addition of several new types of emissions rates. In fact, all the activity-based rates required in the TTI inventory process are now directly available from MOVES, except for the SHP-based rates; these are produced using TTI inventory utilities, recently updated for use with MOVES2014 (see Appendix B for more information on inventory utilities).

Table 5. MOVES Source Use Type/Fuel Types (Vehicle Types).

Source Use Type ID	Source Use Type Description	Source Use Type Abbreviation[1]
11	Motorcycle	MC
21	Passenger Car	PC
31	Passenger Truck	PT
32	Light Commercial Truck	LCT
41	Intercity Bus	IBus
42	Transit Bus	TBus
43	School Bus	SBus
51	Refuse Truck	RT
52	Single Unit Short-Haul Truck	SUShT
53	Single Unit Long-Haul Truck	SULhT
54	Motor Home	MH
61	Combination Short-Haul Truck	CShT
62	Combination Long-Haul Truck	CLhT

[1] The SUT/fuel type, or vehicle type, labels are the combined SUT abbreviation and fuel type names separated by an underscore (e.g., MC_Gas, RT_Diesel, and SBus_Gas are motorcycles, diesel-powered refuse trucks, and gasoline-powered school buses, respectively).

Table 6. MOVES Model On-Road Fleet Emissions Processes.

Process ID	Process Name
1	Running Exhaust
2	Start Exhaust
9	Brake Wear
10	Tire Wear
11	Evaporative Permeation
12	Evaporative Fuel Vapor Venting
13	Evaporative Fuel Leaks
15	Crankcase Running Exhaust
16	Crankcase Start Exhaust
17	Crankcase Extended Idle Exhaust
18[1]	Refueling Displacement Vapor Loss
19[1]	Refueling Spillage Loss
90[2]	Extended Idle Exhaust
91[2]	Auxiliary Power Unit Exhaust

[1] These emissions processes apply only to refueling emissions.
[2] These emissions processes are associated only with the diesel long-haul combination trucks and are directly related to use of the main engine (i.e., extended idling) or a trucks' APU during hotelling periods. APU exhaust is new in MOVES2014.

Table 7 shows emissions factors with associated processes and activity factors used.

Table 7. Emissions Rates by Process and Activity Factor.

<table>
<tr><th>Emissions Processes</th><th>Activity[1]</th><th>Emissions Factor[2]</th></tr>
<tr><td>Running Exhaust
Crankcase Running Exhaust
Brake Wear
Tire Wear</td><td>VMT</td><td>mass/mile</td></tr>
<tr><td rowspan="2">Evaporative Permeation
Evaporative Fuel Vapor Venting
Evaporative Fuel Leaks</td><td>VMT</td><td>mass/mile</td></tr>
<tr><td>SHP</td><td>mass/shp</td></tr>
<tr><td>Start Exhaust
Crankcase Start Exhaust</td><td>starts</td><td>mass/start</td></tr>
<tr><td>Auxiliary Power Exhaust</td><td>APU hours</td><td>mass/APU hour</td></tr>
<tr><td>Extended Idle Exhaust
Crankcase Extended Idle Exhaust</td><td>SHI</td><td>mass/shi</td></tr>
</table>

[1] SHI and APU hours are for combination long-haul trucks only.
[2] All of the rates are directly available from MOVES, except mass/shp, which is produced by the TTI RatesCalc utility using MOVES rates mode input and output data.

Major Components

The county emissions inventory estimation process requires development of the following major inventory components. All are inputs to the emissions calculations, except vehicle populations, which are an intermediate input needed for calculating estimates of SHP and vehicle starts:

- District, four-period, time-of-day, vehicle type VMT mix;
- County, hourly, on-road fleet link VMT and average speeds;
- County vehicle type populations;
- County, hourly vehicle type SHP;
- County, hourly vehicle type starts;
- County, hourly combination long-haul truck SHI and APU hours;
- County, hourly vehicle type emissions rates: mass/mile, mass/SHP, mass/start, mass/SHI, and mass/APU hour; and
- On-road SCCs from MOVES.

The TTI utilities used to develop or process these inventory components are outlined and described in Appendix B, which also includes an inventory production process flow diagram.

VMT Mix

The VMT mix designates the vehicle types included in the analysis, and specifies the fraction of on-road fleet VMT attributable to each vehicle type by MOVES road type.

The VMT mixes were estimated based on TTI's 24-hour average VMT mix method,[1] expanded to produce the four-period, time-of-day estimates. The VMT mix method sets Texas vehicle registration category aggregations for MOVES SUT categories to be used in the VMT mix estimates, as well as for developing other fleet parameter inputs needed in the process (e.g., vehicle age distributions). The current VMT mix method produced a set of four time-of-day period average vehicle type VMT allocations by MOVES road type, estimated for each TxDOT district associated with the five-county San Antonio area (i.e., San Antonio district). The data sources used were recent, multi-year TxDOT vehicle classification counts, year-end TxDOT/Texas Department of Motor Vehicles (TxDMV) registration data, and MOVES default data, where needed.

Weekday On-Road Fleet Link-VMT and Speeds

Summer weekday fleet VMT and average operational speed inputs to the roadway-based emissions calculations (product of "mass per mile" emissions factors and VMT) were required.

TTI used data sets extracted from the latest, non-directional, regional San Antonio 2010 travel model, along with control total-based seasonal adjustments, directional splits, and hourly allocation factors estimated by TTI to estimate the summer weekday hourly, directional, link-VMT (consistent with HPMS VMT) and associated average fleet speed inputs to the emissions calculations. The seasonal period, day type, and hourly distributions used were based on factors developed with TxDOT Automatic Traffic Recorder (ATR) data from the San Antonio TxDOT District. The hourly average operational fleet speeds were estimated corresponding to the link VMT estimates using the TTI speed model, which estimates delay (as a function of volume-to-capacity [v/c]) on each link, and applies it to the link's estimated free-flow speed.

Vehicle Population and Weekday Off-Network Vehicle Activity Estimates

The non-roadway, travel-related, on-road mobile source emissions estimates (e.g., from vehicle starts, parked vehicle evaporative processes, and hotelling activity consisting of extended idling and APU usage) were calculated as the product of the amount of associated activity and the pollutant mass per unit of activity (emissions factor terms as shown in Table 7). To estimate the SHP and vehicle starts activity, SUT/fuel type category population estimates were needed. Hotelling activity estimates (comprising the SHI and APU hours) were based on county-specific actual estimates.[2]

Vehicle Type Populations: TTI based the vehicle population estimates on registration data and vehicle population factors derived from the VMT mix. For historical years, the vehicle type vehicle population estimates were based solely on mid-year TxDOT (or TxDMV) county registrations data and regional, all roads-weekday VMT mix-based population factors for the analysis year.

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[1] *Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009.
[2] *Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study*, ERG, August 2004.

***Weekday SHP*:** The SHP is estimated as a function of total hours (hours a vehicle exists) minus its hours of operation on roads (source hours operating [SHO], which is the same as vehicle hours of travel [VHT]). For historical years, the vehicle type SHP estimates were based on VMT mix, link VMT and speeds, and the vehicle population estimates. The VMT mix was applied to the link VMT to produce vehicle type-specific VMT estimates. Link VMT was divided by the associated speed to produce SHO estimates, which were subtracted from the source hours resulting in SHP estimates. This was performed for each county by year and hour.

Weekday Starts: Engine starts were based on the MOVES national default starts per vehicle, and the local county vehicle type population estimates. MOVES default weekday starts per vehicle were used. The starts were calculated as the product of starts/vehicle from MOVES, and the county vehicle type population estimates. This was performed for each analysis year by county and hour.

Weekday SHI and APU Hours: The SHI and APU hours comprise the diesel combination long-haul truck hotelling hours, estimated based on information from the TCEQ *Extended Idling Study* (ERG, August 2004), and additional factors developed by TTI. Hotelling activity for a 2004 base year was derived from the 2004 idle activity study summer weekday extended idling hours estimates by Texas county. TTI used summer weekday 24-hour 2004 base hotelling estimates derived from this study in combination with 2004 base year and inventory analysis year link VMT and VMT mixes to produce county, hourly hotelling activity estimates for each analysis year. Hotelling hourly factors (estimated by inverting hourly VMT factors) were then applied to allocate the 24-hour hotelling hours estimates for each year to each hour of the day. Estimated proportions of SHI and APU hours were used to divide hourly hotelling hours into SHI and APU hours activity.

Weekday MOVES Emissions Factors

TTI produced the emissions rate look-up table inputs to the emissions calculations in three basic steps: set up and execute the MOVES emissions rate mode runs; perform the initial post-processing, which calculates rates in the form needed that are not directly available from MOVES; and perform the final post-processing to screen out un-needed pollutants and make needed adjustments.

Local emissions factor modeling input parameters were developed and used to produce emissions factors reflective of the local scenario conditions (e.g., weather and fleet characteristics, fuel properties, and I/M program). MOVES county scale, emissions rate mode rates were produced by pollutant, process, speed (for roadway-based processes), hour, road type, and average SUT/fuel type. MOVES data were post-processed: first to produce the emissions rates from emissions and activity input/output (i.e., the mass/SHP form of off-network evaporative rates not available from MOVES) and tabulated with the other MOVES-produced activity-based rates needed (mass/mile, mass/hour, mass/start) into databases of emissions rate look-up tables; and finally to extract the rates from the previous step for only those pollutants needed in the emissions calculations, and to make required adjustments (i.e., apply estimated TxLED effects on diesel vehicle NO_x rates).

County-level hourly emissions factors were developed for the MOVES weekday day type for each year. Actual, local, scenario-specific activity estimates for each county were then combined with the associated emissions rates in the emissions calculations outside of, or external to the MOVES model.

Weekday Emissions Calculations

Average summer weekday emissions were calculated for each county using the previously described major inputs: TxDOT district-level time-of-day VMT mix by MOVES road type; county, hourly on-road fleet link VMT and speed estimates; county hourly off-network activity estimates by vehicle type of SHP, starts, SHI, and APU hours (for CLHT diesel only); and county-level look-up tables of hourly emissions rates by MOVES road type, speed bin, vehicle type (SUT/fuel type), and emissions process.

For the VMT-based calculations, county-to-TxDOT district, TDM road type/area type-to-MOVES road type, and hour-of-day to time-of-day period designations were used to match the appropriate VMT mixes with the link VMT. The VMT mixes by MOVES road type were multiplied by the link fleet VMT to distribute each link's VMT to the different vehicle type categories. Emissions rates for each link's average speed were interpolated (see procedure in Appendix B) from the appropriate set of look-up table emissions factors and corresponding index speeds (i.e., the average bin speeds of 2.5, 5.0, 10.0, 15.0, … 75.0 mph), bounding the link's average speed. For link speeds below or above the minimum and maximum average bin speeds of 2.5 and 75 mph, the rates for those bounding speeds were used. The estimated vehicle type and MOVES road type link speed-specific emissions factors for each pollutant process were then multiplied by the associated VMT to produce the link-based emissions estimates. This process was performed for each county, hour, and analysis year.

For the off-network emissions calculations, which are county level, the vehicle type emissions factors were multiplied by the associated county total activity estimate, as determined by the pollutant process. This process was performed for each county, hour, and analysis year.

There are two types of tab-delimited output: a standard output and an SCC-based output. The standard tab-delimited output file for each county organizes the emissions estimated by pollutant/process, roadway type, and SUT/fuel type combination for each hour, and for the 24-hour period. This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity, VMT, VHT, and speed by roadway. The SCC-based output organizes the 24-hour activity and emissions by the SCCs in MOVES retaining the fuel type, source type, road type, and emissions process level of detail. The SCC-based inventory summaries were converted to NEI CERS XML-type format for uploading to the TexAER. Appendix A contains more detailed output definitions and specifications.

TTI developed and maintains a series of computer utilities to calculate and summarize detailed on-road mobile source emissions inventories in various formats, such as those used in this analysis. Appendix B describes these applications.

Annual Activity and Emissions

The annual activity and emissions were calculated by converting (or annualizing) the average summer weekday emissions using two sets of annualization factors: activity annualization factors and emissions rate annualization factors. The activity annualization factors (VMT, hotelling hours for SHI and APU hours, starts, and SHP) were developed using annual activity (developed using similar calculation procedures to MOVES) and the average summer weekday activity. The activity annualization factors were calculated by dividing the calculated annual activity by the summer weekday activity from the emissions inventory development process.

The emissions rate annualization factors were developed using the emissions and activity output from annual and summer weekday MOVES inventory mode runs. Annual and summer weekday emissions rates were calculated by dividing the MOVES emissions output by the appropriate MOVES activity output, producing both annual and summer weekday emissions rates. The emissions rate annualization factors were calculated by dividing the annual emissions rate by the summer weekday emissions rate.

The annual activity was calculated by multiplying the summer weekday activity by the appropriate activity annualization factor. The annual emissions were calculated by multiplying the summer weekday emissions by the appropriate activity annualization factor and emissions rate annualization factor. In some cases, emissions rate annualization factors do not exist due to the lack of emissions in the summer weekday MOVES inventory mode run. In these cases, the annual emissions were calculated by multiplying the annual emissions rate by the annual activity.

DEVELOPMENT OF VEHICLE TYPE VMT MIX

On-road mobile source emissions are dependent upon the VMT assigned to each vehicle category, making the VMT mix (an estimate of the fraction of on-road fleet VMT attributable to each SUT by fuel type) a major input to the MOVES link-based emissions estimation process. The VMT mix is used to distribute link VMT values to each vehicle category. Since the VMT mix can vary by time-of-day (and thus have an effect on the emissions totals), the TTI VMT mix procedure allows the option to develop VMT mix by time period. Time period VMT mix (by MOVES roadway type and vehicle type) consists of four time periods: morning rush hour (AM peak), mid-day, evening rush hour (PM peak), and overnight.

TxDOT district-level, time period, day-of-week vehicle type VMT mixes (for gasoline-powered and diesel-powered vehicles) were estimated by the four MOVES road-type categories following the TTI methodology.[3] This methodology characterizes VMT by vehicle type for a region (or district) as follows.

- TxDOT Classification Counts by County and TxDOT District — This is the standard TxDOT classification data assembled and used for determining the in-use road fleet mix.
- Redefine Roadway Functional Classifications from Federal Highway Administration (FHWA)/TxDOT to MOVES types — A straightforward transposition of FHWA/TxDOT roadway functional classifications in the classification count data into the five MOVES road types.
- Define MOVES vehicle categories. For example, PV21 – Passenger vehicles (PV) equivalent to FHWA C minus .001 for MCs.

[3] *Methodologies for Conversion of Data Sets for MOVES Model Compatibility*, TTI, August 2009, and *Update of On-Road Inventory Development Methodologies for MOVES2010b*, TTI, August 2013.

- Define MOVES vehicle categories - Passenger and Light Commercial Trucks — Separates FHWA light-truck category (P) into passenger trucks and light commercial vehicles using approximate (rounded) MOVES default values.
- Define MOVES vehicle categories - Single-Unit Trucks RTF51 — These are refuse trucks. These are currently assigned a nominal default value (.001) taken from the combined FHWA single-unit truck category total (SU2, SU3, and SU4).
- Define MOVES vehicle categories - Single-Unit Trucks Short-Haul versus Long-Haul (SUSH52 and SULH53) per SUT_SSHX — Separates single-unit trucks into short-haul and long-haul based on local (TxDOT district) registrations versus observed vehicles from the classification counts. District allocations verified against statewide allocation.
- Define MOVES vehicle categories - Single-Unit Trucks MH54 — These are motor homes/recreational vehicles. These are currently assigned a MOVES default value taken from the combined FHWA single-unit truck category total (SU2, SU3, and SU4).
- Define MOVES vehicle categories - Buses — These are assigned MOVES defaults, which vary by analysis year.
- Define MOVES vehicle categories - Combination Trucks Short-Haul versus Long-Haul (CSH61 and CLH62) — Separates combination trucks into short-haul and long-haul categories based on local (TxDOT district) registrations versus observed vehicles from the classification counts. District allocations verified against statewide allocation.
- Define MOVES vehicle categories - MCs — Nominal default value taken from passenger cars (FHWA C).
- Fuel Type Allocation - PV and light-duty truck (LDT) fuel type allocation per TxDOT registration data and MOVES defaults (21, 31, and 32) — Other fuel types currently treated as *de minimus*. Additional fuel types can be incorporated as local or regional data become available, or from the MOVES national default database (though this latter option is not recommended). Note allocation of fuel type varies with analysis year.
- Fuel Type Allocation - Single Unit and Combination Trucks per TxDOT registration data — As with PV and LDT, other fuel types currently treated as *de minimus*.
- Aggregate and calculate MOVES SUTs and apply day-of-week factors from urban area classification count data (Friday, Saturday, and Sunday).

TxDOT district-level weekday vehicle type VMT mixes by MOVES road-type category (included as Appendix C) were produced based on recent multi-year vehicle classification counts and appropriate end-of-year TxDOT vehicle registrations data. Using the same data sets and a similar procedure, aggregate (i.e., all road-type categories) TxDOT district-level weekday vehicle type VMT mixes (used in the vehicle population estimation) were also produced and included as Appendix D. To ensure general applicability and consistency across all study areas, all VMT mixes were developed in five-year increments beginning with the year 2000 and applied to the analysis years based on Table 8.

Table 8. VMT Mix Year/Analysis Year Correlations.

VMT Mix Year	Analysis Years
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032
2035	2033 through 2037
2040	2038 +

ESTIMATION OF SUMMER WEEKDAY VMT

The detailed, hourly, link-based emissions process requires VMT estimates by hour and direction for each link in the TDM. This analysis also required that VMT be adjusted for HPMS consistency and to reflect estimated levels characteristic of a typical summer weekday. The TRANSVMT utility (see Appendix B for a description of the utility), the latest available data sets from the San Antonio 2010 TDM, and post-processing factors developed from several other data sources, were used to produce this hourly VMT by direction. The hourly and 24-hour VMT and VHT summaries by county and road type were provided electronically to TCEQ (see Appendix A for electronic data descriptions).

Data Sources

The latest available link data, trips data, and zonal radii data sets from the San Antonio 2010 TDM (assignment dated February 9, 2015) were used to estimate the directional link VMT and speeds by hour. Since intrazonal VMT are not accounted for in the TDM, the intrazonal VMT was estimated using the TDM's trip matrix and zonal radii data sets.

Several other data sources were used to adjust the VMT for HPMS consistency and to estimate the summer weekday VMT. The first data source is HPMS VMT estimates, which are based on traffic count data collected according to a statistical sampling procedure specified by the FHWA designed to estimate VMT. The county total HPMS Annual Average Daily Traffic (AADT) VMT was used to ensure the travel model VMT was consistent with the HPMS VMT estimates. (EPA and FHWA have endorsed HPMS as the appropriate source of VMT and require that VMT used to construct on-road mobile source emissions estimates be consistent with that reported through HPMS.)

The second data source is ATR vehicle counts, which are collected by TxDOT at selected locations throughout Texas on a continuous basis. These vehicle counts are available by season, month, and weekday, as well as on an annual average daily basis (i.e., AADT). The counts are very well suited for making seasonal, day-of-week, and time-of-day comparisons (e.g., seasonal adjustment and hourly allocation factors), even though there may be relatively few ATR data collection locations in any given area. Multiple years (2004 through 2013) of data from the ATR stations were grouped for this analysis at the TxDOT district level, with the data for the San Antonio TxDOT District used to develop these factors.

VMT Adjustments

The TDM VMT was adjusted for HPMS consistency and for seasonality (i.e., summer weekday). For estimating VMT, 2014 for this analysis was considered a historical year and county-level 2014 summer weekday VMT control totals were used to develop VMT adjustment factors.

County-level VMT adjustment factors were calculated by dividing the county's respective control total by the county's respective total TDM VMT (TDM assignment VMT plus intrazonal VMT estimate) from the 2010 TDM (producing a total of five county-level VMT adjustment factors, one for each county). For each link in the TDM, the volume was multiplied by the corresponding VMT adjustment factor (based on the county where the link is located). The adjusted link volumes were then multiplied by the associated link lengths to produce the 2014 link-level HPMS consistent, summer weekday VMT estimates. Table 9 shows the 2014 summer weekday VMT control totals, the total TDM VMT, and the VMT adjustment factors for each county.

Table 9. San Antonio 2014 Summer Weekday VMT Control Totals and VMT Adjustment Factors.

County	VMT Control Total	TDM VMT[1]	VMT Adjustment Factor
Bexar	43,946,656	43,594,742	1.008072390
Comal	4,651,102	4,851,397	0.958713861
Guadalupe	3,940,291	3,773,134	1.044302013
Kendall	1,145,903	1,248,749	0.917641030
Wilson	1,335,707	1,176,596	1.135229558

[1] 2010 TDM, including intrazonal VMT.

Hourly Travel Factors

Hourly travel factors were used to distribute the TDM and intrazonal VMT to each hour of the day. These hourly travel factors were developed using multi-year (2004 through 2013) aggregated ATR station data for the San Antonio TxDOT District. Each factor (i.e., 24, or one for each hour of the day) was then multiplied by the link volume (in addition to the other VMT adjustment factors). These adjusted link volumes were then multiplied by their respective link lengths to estimate the hourly link level, 2014 summer weekday VMT estimates. These factors were also multiplied by the estimated intrazonal VMT to produce the final hourly-adjusted VMT. Table 10 shows the weekday hourly travel factors.

Table 10. Summer Weekday Hourly Travel Factors.

Hour	Hourly Factor
12:00 a.m.	0.009817
1:00 a.m.	0.006493
2:00 a.m.	0.005688
3:00 a.m.	0.005443
4:00 a.m.	0.008452
5:00 a.m.	0.020000
6:00 a.m.	0.050486
7:00 a.m.	0.071262
8:00 a.m.	0.059428
9:00 a.m.	0.049299
10:00 a.m.	0.048467
11:00 a.m.	0.052209
12:00 p.m.	0.054540
1:00 p.m.	0.056197
2:00 p.m.	0.059268
3:00 p.m.	0.067715
4:00 p.m.	0.077154
5:00 p.m.	0.081120
6:00 p.m.	0.061665
7:00 p.m.	0.044313
8:00 p.m.	0.035960
9:00 p.m.	0.032213
10:00 p.m.	0.025253
11:00 p.m.	0.017558

Time-of-Day Directional Split Factors

The TDMs for the San Antonio area are also non-directional (i.e., speed and volume are only listed for the link, not in both directions). Directional split factors were used to produce the VMT and speeds by direction. These factors were multiplied by the link volume to estimate the volume of travel in each direction, one record containing the estimated volume in the peak (or dominant) direction, and the second record containing the estimated volume in the opposite direction. These directional volume estimates were used not only to estimate the VMT in each direction, but also to estimate the directional speeds (discussed in the next section). Appendix E contains the directional split estimates.

The directional split factors were developed for application by time-of-day period (Table 11), at the functional classification (Table 12), and area type level (Table 13).

Table 11. Time-of-Day Travel Periods.

Period	Hours
AM Peak	6 a.m. - 9 a.m.
Mid-Day	9 a.m. – 4 p.m.
PM Peak	4 p.m. – 7 p.m.
Overnight	7 p.m. - 6 a.m.

Table 12. San Antonio TDM Facility Types.

Facility Type Code	Facility Type Description
0	Centroid Connector
1	Radial IH Freeways - Mainlanes Only
3	Circumferential IH Freeways (Loops) - Mainlanes Only
5	Radial Other Freeways - Mainlanes Only
7	Circumferential Other Freeways (Loops) - Mainlanes Only
9	Radial Expressways
10	Circumferential Expressways
11	Principal Arterial – Divided
12	Principal Arterial - Continuous Left Turn Lane
13	Principal Arterial – Undivided
14	Minor Arterial – Divided
15	Minor Arterial - Continuous Left Turn Lane
16	Minor Arterial – Undivided
17	Collector – Divided
18	Collector - Continuous Left Turn Lane
19	Collector - Undivided
20	Frontage Road
21	Ramp (Between Frontage Road and Mainlanes)
22	Interchange Ramp (Freeway-to-Freeway Interchange Ramps)

Table 13. San Antonio TDM Area Types.

Area Type Code	Area Type Description
1	Central Business District (CBD)
2	CBD Fringe
3	Urban
4	Suburban
5	Rural

ESTIMATION OF LINK SPEEDS

To estimate link operational (congested) speeds, a speed model involving both the link estimated free-flow speed and estimated directional delay (as a function of volume and capacity) was used. This model was used to estimate the hourly, directional, congested speed for each link, except for the TDM centroid connectors and added intrazonal links. The congested speed was calculated using the following formula:

$$Congested\ Speed = \frac{60}{\dfrac{60}{Freeflow\ Speed} + Delay}$$

Free-flow speed factors were used to convert TDM speeds (which are by definition level of service [LOS] C) to LOS A speeds (free flow). For each facility type and area type combination, the free-flow speed factors were calculated by dividing the free-flow speed by the corresponding speed from the speed/capacity look-up table used for the TDM. The free-flow speeds were determined using the Highway Capacity Manual (HCM), using suitable assumptions to relate the HCM data to the facility types used in the TDMs. Appendix F) shows the free-flow speed factors used by area-type/functional-class combination.

The second component of the speed model used to calculate the congested speed is the estimated directional delay. The directional delay (in minutes per mile) due to congestion was calculated using the following volume/delay equation:

$$Delay = Min\left[A\,e^{B(\frac{V}{C})}, M \right]$$

Where:

Delay = congestion delay (in minutes/mile);
A & B = volume/delay equation coefficients;
M = maximum minutes of delay per mile; and
V/C = time-of-day directional v/c ratio.

The delay model parameters (A, B, and M) were developed for the Dallas/Fort Worth area and verified by application in other Texas urban areas. Table 14 shows these parameters, followed by Table 15, which lists the functional classes used in the TDMs and their capacity category (except for centroid connector and intrazonal, which do not use capacity data).

Table 14. Volume/Delay Equation Parameters.

Facility Category	A	B	M
High-Capacity Facilities	0.015	3.5	5
Low-Capacity Facilities	0.050	3.0	10

Table 15. Facility Type Categories for Applying Delay Parameters.

Category	TDM Facility Type Code	TDM Facility Type Description
High-Capacity	1	Radial IH Freeways - Mainlanes Only
	3	Circumferential IH Freeways (Loops) - Mainlanes Only
	5	Radial Other Freeways - Mainlanes Only
	7	Circumferential Other Freeways (Loops) - Mainlanes Only
	9	Radial Expressways
	10	Circumferential Expressways
	22	Interchange Ramp (Freeway-to-Freeway Interchange Ramps)
Low-Capacity	11	Principal Arterial – Divided
	12	Principal Arterial - Continuous Left Turn Lane
	13	Principal Arterial – Undivided
	14	Minor Arterial – Divided
	15	Minor Arterial - Continuous Left Turn Lane
	16	Minor Arterial – Undivided
	17	Collector – Divided
	18	Collector - Continuous Left Turn Lane
	19	Collector - Undivided
	20	Frontage Road
	21	Ramp (Between Frontage Road and Mainlanes)

The time-of-day directional v/c ratios were estimated using the directional volume (from the VMT estimation) and the time-of-day directional capacity. However, the 24-hour user equilibrium assignments were performed using non-directional 24-hour capacities. To estimate the time-of-day directional capacity, the directional split for capacity was assumed at 50/50 and capacity factors were multiplied by the non-directional capacity for each link. Appendix F summarizes the capacity factors for the San Antonio region TDMs by area type/facility type combination. Capacity factors were calculated using the following formula:

$$Capacity\ Factor = \frac{(Hourly\ Capacity\ per\ Lane)(Length\ of\ the\ Time\ Period)}{24\text{ - }Hour\ Capacity\ per\ Lane}$$

Capacity data are not used, however, for the centroid connector links and the added intrazonal links (added specifically for air emissions analyses). The centroid connector traffic assignment input speeds were used as the centroid connector operational speeds estimates. Operational speeds for the intrazonal trips category were estimated by zone as the average of the zone's centroid connector speeds.

The hourly and 24-hour speed (VMT/VHT) summaries by county and road type were provided electronically (see Appendix A for electronic data descriptions).

ESTIMATION OF SUMMER WEEKDAY OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates (i.e., mass per SHP, mass per start, and mass per SHI), county-level analysis year (2014) summer weekday estimates of the SHP, starts, SHI, and APU hours are required by hour and vehicle (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the analysis year county-level vehicle population. Appendix G contains summaries of the vehicle population and 24-hour SHP, starts, SHI, and APU hours off-network activity. Hourly SHP, starts, SHI, and APU hours activity estimates are included with the detailed inventory data provided (see inventory data file descriptions in Appendix A).

The county-level vehicle population estimates were developed using the MOVESpopulationBuild utility. The county-level SHP, starts, SHI, and APU hours of off-network activity were developed using the OffNetActCalc utility. Appendix B contains a description of the utilities.

Estimation of Vehicle Population

The vehicle type population estimates are needed to estimate the SHP and starts off-network activity. The analysis year vehicle population estimates (included as Appendix G) were produced for each county. The vehicle population estimates are a function of vehicle registration data (2014 TxDMV registration data sets) and the aggregate (i.e., all road-type categories) TxDOT district-level weekday VMT mix (described in more detail in the "Development of Vehicle Type VMT Mix" section and included as Appendix D).

The analysis year county-level vehicle population estimates were calculated using the 2014 county-level, mid-year TxDMV vehicle registrations and the assigned aggregate VMT mix (see Table 8 and Appendix D). The vehicle population estimation process assumes that all of the non-long-haul SUT category populations for a county are represented in the county vehicle registrations data. This process also estimates the long-haul category populations as an expansion of the county registrations. There are three main steps in the vehicle population estimation process: registration data category aggregation, calculation of the vehicle type population factors, and estimation of the county-level vehicle population by vehicle type.

The first step in the vehicle estimation process is the registration data category aggregation. For each county, the analysis year vehicle registrations were aggregated into five categories. Table 16 shows these five categories.

Table 16. Registration Data Categories.

Registration Data Category	Vehicle Registration Aggregation
1	Motorcycles
2	Passenger Cars (PC)
3	Trucks <= 8.5 K gross vehicle weight rating (GVWR) (pounds)
4	Trucks > 8.5 and <= 19.5 K GVWR
5	Trucks > 19.5 K GVWR

The second step is calculating the vehicle type population factors. Using the assigned aggregate VMT mix, population factors were calculated for each vehicle type. For the non-long-haul SUT categories, the population factors were calculated by dividing the vehicle type VMT mix by the summed total of the VMT mix fractions in its associated vehicle registration data category. For example, the LCT_Diesel population factor using the VMT mix is LCT_Diesel/(PT_Gas + PT_Diesel + LCT_Gas + LCT_Diesel). For the long-haul SUTs, the vehicle type population factors were calculated by taking the ratio of the long-haul and short-haul VMT mix values. For example, the SULhT_Gas population factor using SUT mix fractions is SULhT_Gas/SUShT_Gas. Table 17 shows the vehicle registration aggregations and their associated MOVES SUT/fuel types.

Table 17. TxDMV Vehicle Registration Aggregations and Associated Vehicle Types for Estimating Vehicle Populations.

Vehicle Registration[1] Aggregation	Associated Vehicle Type[2]
Motorcycles	MC_Gas
Passenger Cars (PC)	PC_Gas; PC_Diesel
Trucks <= 8.5 K GVWR (pounds)	PT_Gas; PT_Diesel; LCT_Gas; LCT_Diesel
Trucks > 8.5 and <= 19.5 K GVWR	RT_Gas; RT_Diesel SUShT_Gas; SUShT_Diesel MH_Gas; MH_Diesel IBus_Diesel TBus_Gas; TBus_Diesel SBus_Gas; SBus_Diesel
Trucks > 19.5 K GVWR	CShT_Gas; CShT_Diesel
NA[1]	SULhT_Gas; SULhT_Diesel CLhT_Gas; CLhT_Diesel

[1] The four long-haul SUT/fuel type populations are estimated using a long-haul-to-short-haul weekday SUT VMT mix ratio applied to the short-haul SUT population estimate.
[2] The mid-year TxDMV county registrations data extracts were used (i.e., the three-file data set consisting of: 1 - light-duty cars, trucks, and motorcycles; 2 - heavy-duty diesel trucks; and 3 - heavy-duty gasoline trucks) for estimating the vehicle populations.

The third step is the estimation of the county-level vehicle type population. The non-long-haul vehicle type populations were estimated by applying their vehicle type population factors to the appropriate registration data category. For the CLhT_Gas type, the vehicle population was set to 0. For the remaining three long-haul SUT/fuel types (SULhT_Gas, SULhT_Diesel, and CLhT_Diesel), the vehicle populations were calculated as the product of the corresponding short-haul category vehicle population and the associated long-haul population factor (e.g., SULhT_Gas vehicle population = SUShT_Gas vehicle population x [SULhT_Gas SUT mix fraction/ SUShT_Gas SUT mix fraction]).

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year summer weekday estimates of SHP by hour and vehicle type. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type SHO. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The SHO was calculated using the link VMT and speeds and the TxDOT district-level vehicle type VMT mixes by MOVES road-type category (see the “Development of Vehicle Type VMT Mix” section for more details). Appendix G includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Vehicle Type Total Available Hours

The vehicle type total available hours is typically calculated as the vehicle type population times the number of hours in the time period. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type vehicle.

Vehicle Type SHO

To calculate the VHT (or SHO) for a given link, the VMT was allocated to each vehicle type using the TxDOT district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type SHO. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 8 and Appendix C). This SHO calculation was performed for each link in a given hour, aggregating the SHO to one value per vehicle type per hour.

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year summer weekday estimates of starts by hour and vehicle type. The vehicle type hourly default starts per vehicle were multiplied by the analysis year county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix G includes the 24-hour summaries of the county-level vehicle type starts by hour for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

For the hourly default starts per vehicle, the MOVES defaults were used. The MOVES activity output was used to estimate the hourly starts per vehicle for a MOVES weekday run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES national default starts per vehicle do not vary by year, only by MOVES day type. For this summer weekday analysis, the MOVES national default "weekday" starts per vehicle were used.

Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level analysis year summer weekday heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) SHI and APU hours (hotelling activity). During hotelling, the truck's main engine is assumed to be in idling mode or its APU is in use. To calculate the SHI and APU hours activity, the hotelling hours activity were calculated, which was then allocated to the SHI and APU hours components.

The hotelling activity was based on information from a TCEQ extended idling study, which produced 2004 summer weekday extended idling estimates for each Texas county, and hotelling activity data from MOVES. Hotelling scaling factors (by analysis year) were applied to the base 2004 summer weekday hotelling values from the study to estimate the 24-hour hotelling by analysis year. Hotelling hourly factors were then applied to allocate the 24-hour hotelling by analysis year to each hour of the day. To ensure that valid hourly hotelling values are used, the hourly hotelling activity was compared to the CLhT_Diesel hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity. Appendix G incudes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours for each analysis year (hourly summaries were provided electronically to TCEQ; see Appendix A for electronic data descriptions).

Hotelling Activity Scaling Factors

To estimate the analysis year county-level 24-hour hotelling activity, county-level hotelling activity scaling factors were developed using the county-level 2004 summer weekday link-level VMT and speeds, the TxDOT district-level base weekday vehicle type VMT mix (by MOVES road type), the county-level analysis year summer weekday link-level VMT and speeds, and the TxDOT district-level analysis year vehicle type VMT mix (by MOVES road type). The 2004 summer weekday link-level VMT and speeds were developed using a process similar to the 2014 summer weekday link-level VMT speed estimation, except using 2004 summer weekday VMT control totals. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process (see Table 8 and Appendix C). For the base weekday vehicle type VMT mix, the 2005 weekday vehicle type VMT mix was used.

For each link in the 2004 summer weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday vehicle type VMT mix. This VMT allocation was performed for each link and hour in the 2004 summer weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24-hour 2004 summer weekday VMT. Using a similar allocation process, the analysis year summer weekday CLhT_Diesel hourly and 24-hour VMT was calculated using the analysis year summer weekday link-level VMT and speeds and the analysis year vehicle type VMT mix. The county-level 24-hour hotelling activity scaling factors by analysis year were calculated by dividing the analysis year and day type CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2004 summer weekday VMT.

Hotelling Activity Hourly Factors

To allocate the analysis year summer weekday county-level 24-hour hotelling activity to each hour of the day, hotelling activity hourly factors were used. These hotelling activity hourly factors were calculated as the inverse of the analysis year summer weekday CLhT_Diesel hourly VMT fractions. The analysis year summer weekday CLhT_Diesel hourly VMT fractions were calculated using the hourly analysis year summer weekday CLhT_Diesel VMT. The hourly analysis year summer weekday CLhT_Diesel VMT was converted to hourly fractions, therefore creating analysis year summer weekday CLhT_Diesel hourly VMT fractions. The inverse of these hourly VMT fractions were calculated and the inverse for each hour was divided by the sum of the inverse hourly VMT fractions across all hours to calculate the county-level analysis year summer weekday hotelling activity hourly factors.

County-Level CLhT_Diesel Hotelling Activity by Hour Estimation

The initial analysis year summer weekday CLhT_Diesel hotelling activity by hour was calculated by multiplying the 24-hour 2004 summer weekday hotelling hours by the analysis year hotelling activity scaling factor and by the analysis year hotelling activity hourly factors. For each hour, the initial analysis year weekday hotelling activity was then compared to the analysis year weekday CLhT_Diesel SHP to estimate the final analysis year weekday hotelling activity by hour. If the initial analysis year weekday hotelling activity value was greater than the analysis year weekday SHP value, then the final analysis year weekday hotelling activity for that hour was set to the analysis year weekday CLhT_Diesel SHP value. Otherwise, the final analysis year weekday hotelling activity for that hour was set to the base analysis year weekday hotelling activity value. All calculations (scaling factors, hotelling activity hourly factors, and hotelling activity by hour calculations) were performed by county and analysis year (i.e., five hotelling activity scaling factors were calculated per analysis year).

County-Level CLhT_Diesel SHI and APU Hours Estimation

The analysis year summer weekday hourly county-level hotelling activity was then allocated to SHI and APU hours activity components using the aggregate extended idle mode and APU mode fractions. For each hour, the analysis year summer weekday hotelling activity was multiplied by the SHI fraction to calculate the analysis year summer weekday hourly SHI activity and by the APU fraction to calculate the analysis year summer weekday hourly APU activity.

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the MOVES default hotelling activity distribution (i.e., a bi-modal distribution of 1.0 SHI prior to the 2010 model year and a 0.7/0.3 SHI/APU activity allocation for 2010 and later model years). The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions (which sum to 1.0).

ESTIMATION OF SUMMER WEEKDAY EMISSIONS FACTORS

TTI developed the summer weekday emissions factors for each of the five San Antonio area counties consistent with TTI's MOVES detailed link-based emissions estimation method that was established as an upgrade of the MOBILE6-based inventory process for producing SIP and conformity quality emissions estimates. TTI used EPA's latest MOVES version, the MOVES2014 October Release.[4]

The emissions factors were developed based on the TTI's *Updated Inventory Methods for MOVES*[5] and the EPA's MOVES inventory development *Technical Guidance*[6] and *User's Guide*.[7] (More information may found in these main references, if desired.) TTI's MOVES data post-processing utilities, RatesCalc and RatesAdj used to produce databases of emissions rate look-up tables for input to the emissions calculations, are also summarized in Appendix B of this Technical Report.

The detailed link-based emissions estimation method of analysis requires emissions rates by speed in look-up table form. Emissions rate mode was therefore used to produce emissions rates indexed by 16 MOVES speed bin average speeds. Another requirement of the method is that all rates be in terms of mass per activity unit for the external emissions calculations, thus the appropriate alternatives to the MOVES off-network mass per vehicle rates were used. Table 18

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[4] Software and database (MOVESDB20141021) downloadable from http://www.epa.gov/otaq/models/moves/index.htm.

[5] *Update of On-Road Inventory Development Methodologies for MOVES2014,* TTI, December 2014.

[6] *MOVES2014 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity,* EPA, January 2015.

[7] *Motor Vehicle Emission Simulator (MOVES) User Guide for MOVES1014,* EPA, July 2014.

(which was included in a previous section, but is provided again here for convenience) shows the emissions rates types and associated activity factors.

Table 18. Emissions Rates by Process and Activity Factor.

Emissions Processes	Activity[1]	Emissions Factor[2]
Running Exhaust Crankcase Running Exhaust Brake Wear Tire Wear	VMT	mass/mile
Evaporative Permeation Evaporative Fuel Vapor Venting Evaporative Fuel Leaks	VMT	mass/mile
	SHP	mass/shp
Start Exhaust Crankcase Start Exhaust	starts	mass/start
Auxiliary Power Exhaust	APU hours	mass/APU hour
Extended Idle Exhaust Crankcase Extended Idle Exhaust	SHI	mass/shi

[1] SHI and APU hours are for combination long-haul trucks only.
[2] All of the rates are directly available from MOVES, except mass/shp, which is produced by the TTI RatesCalc utility using MOVES rates mode input and output data.

MOVES Inputs, Outputs, and Post-Processing

The MOVES model is equipped with default modeling values for the range of conditions that affect emissions. MOVES defaults may be replaced by alternate input data sets that better reflect local scenario conditions. Where local data were available and consistent with the methodology, MOVES defaults were replaced by local input values via the MOVES Run Specification (MRS) input file (RunSpec or MRS) and MOVES CDB (county input database). (The MRS, CDB, and MOVES default database provide the data for each local scenario model run.) Inputs were developed and used to produce emissions factors reflecting local conditions including area June through August period average weather conditions, summer fuel properties, vehicle fleet characteristics (e.g., age), and emissions control programs. In the case of the activity input data to MOVES, the MOVES defaults were in general used, which is basic to the emissions rates method (e.g., default activity is normalized in the emissions rates, and the emissions rates are later multiplied by the local activity estimates to calculate emissions external to MOVES).

There is one RunSpec required per county, and a corresponding number of CDBs and output databases (i.e., one output database per run). Therefore, for five counties, there are five RunSpec input files, CDB inputs, MOVES output databases, RatesCalc output databases, and RatesAdj final rate output databases. RatesAdj produces the final rates by performing NO_x TxLED effect adjustments to diesel vehicle NO_x rates, where required, and extracting and storing the rates for the inventoried pollutants in a separate, smaller database for input to the emissions runs.

The RatesCalc and RatesAdj utilities used to produce the emissions rates from the MOVES data are described in Appendix B.

Summary of Control Programs Modeled

Table 19 summarizes the control measures and modeling approaches (e.g., MOVES model defaults versus alternative local inputs, or post-processing of MOVES output).

Table 19. Emissions Control Strategies and Modeling Approaches.

Individual Control Measures	Approach
Federal Motor Vehicle Control Program Standards	MOVES model – defaults.
Federal Heavy-Duty Diesel Engines Rebuild and 2004 Pull-Ahead Programs to Mitigate NO_x Off-Cycle Effects	MOVES model – defaults.
Conventional Gasoline[1]	Local Inputs. Used the TCEQ's summer 2014 statewide retail outlets fuel survey data (non-RFG gasoline samples) to estimate actual summer season 2014 fuel formulations.
Texas Low-Emission Diesel[2]	Sulfur: Local Inputs. Used the TCEQ's summer 2014 statewide retail outlets fuel survey data (diesel samples) to estimate the actual average diesel sulfur levels for the TxLED and non-TxLED region counties. TxLED: For TxLED fuel program counties, post-processed diesel vehicle NO_x emissions factors using evaluation-year-specific average NO_x reduction factors (based on a 4.8% reduction for 2002 and later model year vehicles and a 6.2% reduction for 2001 and earlier model year vehicles).[2]
Inspection and Maintenance Program	Not Applicable.

[1] Kendall County and the other four San Antonio area counties are in separate fuel regions (federal 9.0 RVP limit region and state 7.8 RVP limit region, respectively); the sample data used in the fuel property estimates for each region were applied accordingly.

[2] Consistent with the benefit information described in the EPA *Memorandum on Texas Low Emission Diesel Fuel Benefits* (EPA, September 2001). Kendall County is the only non-TxLED county of the five San Antonio area counties.

MOVES Emissions Factor Aggregation Levels

The MOVES model produces results at different aggregation levels that may be specified in the MRS. The detailed, hourly, link-based inventory method required MOVES weekday day type emissions rates at the following MOVES output detail level:

- Up to 13 source types (i.e., vehicle types);
- Up to six fuel types;
- Up to five road types (four actual MOVES road categories and "off-network");
- Each of the 24 hours in a day;
- 16 speed bins (only included in miles-based rate tables);

- Up to 135 pollutants; and
- Up to 14 emissions processes.

The vehicle fleet was modeled as powered only by the predominant on-road fuels of gasoline and diesel (alternate fuels considered *de minimus*). The five road type categories in MOVES are Off-Network (not actually a road type, this category is for parked vehicle activity), Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, and Urban Unrestricted Access.[8] The rates for each of the actual four MOVES road types are indexed by the 16 MOVES speed bin average speeds: 2.5, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75 mph.

MOVES Run Specifications

The MRS defines the place, time, road categories, vehicle and fuel types, pollutants and emissions processes, and the overall scale and level of output detail for the modeling scenario. TTI created an MRS for one county scenario using the MOVES graphical user interface (GUI), which was then converted to a template and used as a base MRS from which to build the MRSs for the analysis. Table 20 describes the MRS selections TTI used, with further details on the selections provided after the table.

[8] The "separate ramps" feature intended for MOVES2014 October Release was not activated for emissions rates mode, but is expected to be available for emissions rates output in the next release of MOVES.

Table 20. RunSpec Selections by MOVES GUI Navigation Panel.

<table>
<tr><th>Navigation Panel</th><th>Detail Panel</th><th colspan="3">Selection</th></tr>
<tr><td>Scale</td><td>Model; Domain/Scale;
Calculation Type</td><td colspan="3">On-Road; County;
Emissions Rates</td></tr>
<tr><td>Time Spans[1]</td><td>Time Aggregation Level;
Years – Months – Days – Hours</td><td colspan="3">Hour;
2014 - July[1] - Weekday - All</td></tr>
<tr><td>Geographic Bounds</td><td>Region;
Selections;
Domain Input Database</td><td colspan="3">Zone and Link;
<COUNTY>;
<COUNTY INPUT DATABASE (CDB) NAME>[1]</td></tr>
<tr><td rowspan="14">On-Road Vehicle Equipment</td><td rowspan="14">SUT/Fuel Combinations</td><td>SUT</td><td>Gasoline</td><td>Diesel</td></tr>
<tr><td>Motorcycle</td><td>X</td><td>-</td></tr>
<tr><td>Passenger Car</td><td>X</td><td>X</td></tr>
<tr><td>Passenger Truck</td><td>X</td><td>X</td></tr>
<tr><td>Light Commercial Truck</td><td>X</td><td>X</td></tr>
<tr><td>Intercity Bus</td><td>-</td><td>X</td></tr>
<tr><td>Transit Bus</td><td>-</td><td>X</td></tr>
<tr><td>School Bus</td><td>X</td><td>X</td></tr>
<tr><td>Refuse Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Single Unit Long-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Motor Home</td><td>X</td><td>X</td></tr>
<tr><td>Combination Short-Haul Truck</td><td>X</td><td>X</td></tr>
<tr><td>Combination Long-Haul Truck</td><td>-</td><td>X</td></tr>
<tr><td>Road Type</td><td>Selected Road Types</td><td colspan="3">Off-Network –
Rural Restricted Access – Rural Unrestricted Access –
Urban Restricted Access – Urban Unrestricted Access</td></tr>
<tr><td>Pollutants and Processes[2]</td><td>VOC; CO; NOx; SO_2; NH_3; Atmospheric CO_2; PM_{10} Total Exhaust, Brakewear, Tirewear; $PM_{2.5}$ Total Exhaust, Brakewear and Tirewear; and the MOVES HAPs</td><td colspan="3">Dependent on pollutant:
Running Exhaust, Start Exhaust, Extended Idle Exhaust, Auxiliary Power Exhaust, Crankcase Running Exhaust, Crankcase Start Exhaust, Crankcase Extended Idle Exhaust, Evap Permeation, Fuel Vapor Venting, Fuel Leaks, Brakewear, Tirewear</td></tr>
<tr><td>Manage Input Data Sets</td><td>Additional Input Database Selections</td><td colspan="3">None</td></tr>
<tr><td>Strategies</td><td>Rate-of-Progress</td><td colspan="3">Not Applicable</td></tr>
<tr><td>General Output</td><td>Output Database;
Units;
Activity</td><td colspan="3">*<MOVES OUTPUT DATABASE NAME>*;
Pounds, KiloJoules, Miles;
Hotelling Hours, Population, Starts (not adjustable, pre-selected)</td></tr>
<tr><td>Output Emissions Detail</td><td>Always;
For All Vehicles/Equipment;
On Road</td><td colspan="3">Time: Hour – Location: Link – Pollutant;
Fuel Type, Emissions Process;
Source Use Type</td></tr>
<tr><td>Advanced Performance Measures</td><td>Aggregation and Data Handling</td><td colspan="3">All check boxes are to be “un-checked”</td></tr>
</table>

[1] July was selected for summer season runs.

[2] Chained pollutants require other pollutants (not listed in the table) to be selected (e.g., VOC requires Total Gaseous Hydrocarbons [THC] and Non-Methane Hydrocarbons: CO_2 requires Total Energy Consumption [TEC]).

Scale, Time Spans, and Geographic Bounds

The MOVES Domain/Scale "County" was selected as is required for SIP inventory estimates. The MOVES Calculation Type "Emissions Rates" was selected for MOVES to produce the emissions rates with speed bin indexing, as needed for the detailed link-based emissions estimation process.

The Time Spans parameters were specified to provide the most detail available, which is the hourly aggregation level, for all hours of the day, for the selected year, month, and day type. The analysis year, 2014, was selected. For TTI's MOVES-based link emissions estimation process, which is for a single day, one "Months" (July) and one "Days" (Weekdays) selection was made.

Under Geographic Bounds for the County Domain Scale, only one county may be selected. The local CDB containing the calendar year scenario-specific input data for the county was specified as the County Domain Input Database, and under Region, "Zone & Link" was selected as required for the emissions rates calculation type. With these required set-ups, one county, one year, one day type, 24 hours, and 16 (speed bin) average speeds were modeled per run.

On-Road Vehicle Equipment and Road Type

The local VMT mixes developed for the study define the SUT/fuel type combinations included in the MOVES runs. The VMT mixes specify the vehicle fleet as the 22 gasoline and diesel SUTs designated as "on-road vehicle equipment" selections in Table 20. These SUT/fuel type combinations were chosen in all the MOVES RunSpecs. Note that, as required, the MOVES default fuel engine fractions (discussed later) were also replaced with local input data consistent with the SUT/fuel type selections shown in Table 20.

All five MOVES road type categories were selected (the "provide separate ramps output" box is not active when using emissions rates mode in the MOVES2014 October Release model).

Pollutants and Processes

In addition to the required pollutants within the scope of the inventory, MOVES requires that additional pollutants be selected for particular "chained" pollutants (i.e., pollutants that are calculated as a function of another MOVES pollutant). Of the pollutants listed for the inventory, the following additional pollutants were selected, as required by the model, due to chaining: non-methane hydrocarbons and total gaseous hydrocarbons for VOC, and TEC for CO_2 and SO_4. All of the associated processes available by the selected pollutants were included, including the two refueling emissions processes (although emissions for these "area source" category processes were not estimated for this inventory).

Manage Input Data Sets and Strategies

The Manage Input Data Sets feature allows alternate inputs other than those included in the CDB. No additional inputs were included via the Manage Input Data Sets panel.

The Strategies feature is for modeling an alternate control program option, which was not applicable to this inventory analysis.

Output

The output units were pounds, kilojoules, and miles. The activity categories were pre-set by MOVES (and not adjustable) for inclusion in the output database. The output detail level was by hour, link (e.g., for MOVES rates mode, county/road type/speed bin combination), pollutant, process, SUT, and fuel type.

Appendix A lists the electronic data files provided in support of this analysis, which includes the MRSs used.

MOVES County Input Databases

The locality-specific input data for the county scale runs were entered through the CDB.

TTI developed procedures to accommodate building and checking CDBs for large scale emissions inventory estimation projects. The basic procedure was to write a MySQL script to produce one county scenario CDB and convert it to a template from which all of the CDB scripts were built. The MySQL scripts were then run in batch mode to produce all CDBs for the analysis.

Data for populating the CDBs were first prepared in the form of text files and/or MySQL databases (e.g., for local fuels and weather data), and some values provided directly in the CDB builder MySQL script. Any default data used was selected from the latest MOVES default database, MOVESDB20141021 (e.g., for default activity data). After running the scripts to produce the CDBs, a CDB checker utility written by TTI was run to verify that all CDB tables were built and populated as intended.

Table 21 provides an outline and brief description of the CDBs, followed by discussion of the development of the local data and the defaults contained therein. Unless otherwise stated, the CDB table data applies to all counties.

Table 21. CDB Input Tables.

MOVES Input Table	Data Category	Notes
year	Time	Designates analysis year as a base year (base year means that local activity inputs are supplied rather than forecast by the model).
state	Geography	Identifies the state (Texas) for the analysis.
county	Geography/ Meteorology	Identifies county of analysis, local altitude, and barometric pressure (used 2014 county average data – June through August – provided by TCEQ).
zonemonthhour	Meteorology	Local, hourly temperature and relative humidity for the county (used 2014 county average data – June through August – provided by TCEQ).
roadtype[1]	Activity	Lists the MOVES road types and associated ramp activity fractions. Road type ramp fractions were set to 0.
hpmsvtypeyear[2]	Activity	Used MOVES default national annual VMT by HPMS vehicle type.
roadtypedistribution[2]		Used MOVES default road type VMT fractions.
monthvmtfraction[2]		Used MOVES default month VMT fractions.
dayvmtfraction[2]		Used MOVES default day VMT fractions.
hourvmtfraction[2]		Used MOVES default hour VMT fractions.
avgspeeddistribution[2]		Used MOVES default average speed distributions.
sourcetypeyear[2]	Fleet	Used MOVES default national SUT populations.
sourcetypeage-distribution	Fleet	Estimated SUT age fractions by county using TxDMV 2014 mid-year vehicle registration data and MOVES defaults, as needed.
avft	Fleet	Estimated statewide SUT fuel fractions using TxDMV 2014 mid-year, statewide vehicle registration data and defaults where needed.
zone	Activity	Start, idle, and SHP zone allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
zoneroadtype	Activity	SHO zone/roadtype allocation factors. County = zone, and all factors were set to 1.0 (required for county scale analyses).
fuelsupply	Fuel	The fuel supply, or market shares, reflected one gasoline and one diesel fuel formulation for each county.
fuelformulation	Fuel	Average gasoline and diesel fuel properties were based on local retail outlet fuel survey sample data (i.e., summer 2014 TCEQ survey data), aggregated and applied by applicable fuel regions.
imcoverage	I/M	Not applicable. (An empty table was included.)
countyyear	Stage II	Included table in CDB as standard procedure, but not applicable to this analysis, and has no effect on resulting emissions inventories.

[1] MOVES will not produce "ramp road type" rates in a single run with all road types. To calculate emissions for certain travel model links coded as ramps, MOVES Unrestricted Access road type emissions rates were used.

[2] Use of a default set of activity and population inputs for all MOVES runs is basic to the inventory method, e.g., MOVES default activity is normalized in the calculated emissions rates for applicable emissions processes, and actual local activity estimates are used in the external emissions calculations.

User Inputs – Locality Specific Inputs and Defaults Used

All inputs discussed in this section are input via the CDB. Unless otherwise stated, the inputs apply to all counties.

Year, State, and County Inputs to MOVES – The year, state, and county tables are populated with data identifying the year, state, and county of the run.

The yearID field of the "year" table was populated with the analysis year value, and the year was set as a base year (to specify that particular user-input fleet and activity data were to be used, rather than forecast by MOVES during the model runs). As part of designating the appropriate fuel supply for the modeling scenario, the fuelyearID in the year table was also set to the analysis year.

StateID "48" (Texas) was inserted in the state table. In addition to identifying the county of analysis, the county table contains barometric pressure and altitude information (discussed further with other meteorological inputs). The county data were selected from a prepared local "meteorology" database containing tables of weather data records (i.e., "county" and "zonemonthhour" tables) for the analysis.

Roadtype Inputs to MOVES **–** Currently the MOVES model contains "ramp" emissions rates, but not an (activated) individual road type for separate ramps output (when using MOVES rates mode). In the roadtype table, MOVES provides a field "rampFraction" for including a fraction of estimated ramp activity as a fraction of SHO on each of the MOVES road types. For this analysis, the MOVES default roadtype table data were used, except the ramp fractions were set to zero (i.e., 100 percent of activity on each MOVES road type was based on the road type drive cycles assigned to that road type by MOVES, exclusive of ramp activity).

Activity and Vehicle Population Inputs to MOVES **–** The activity and vehicle population input parameters under the methodology use the MOVES defaults. The tables are: hpmsvtypeyear, roadtypedistribution, monthvmtfaction, dayvmtfraction, hourvmtfraction, avgspeeddistribution, and sourcetypeyear. Data for all of these tables were selected and inserted from the MOVES default database.

The zone and zoneroadtype tables contain zonal sub-allocation activity factors. For county scale analyses, county is equal to zone, therefore these allocation factors were set to 1.0.

Age Distributions and Fuel Engine Fractions Inputs to MOVES **–** The locality-specific fleet characteristics inputs to MOVES consist of county age distributions input data sets and statewide fuel engine fractions (formerly known as diesel sales fractions) input data sets. The age distributions and fuel engine fractions inputs were calculated and written to text files in preparation for loading the data into the appropriate CDB input tables: the sourcetypeagedistribution table for vehicle age distributions, and the AVFT table for fuel engine fractions. The MOVESfleetInputBuild utility was used to produce these fleet inputs to MOVES in the required formats (see utility description in Appendix B), and MySQL scripts were used to populate the CDB input tables.

The age distributions and fuel engine fractions were based on TxDMV mid-year county registrations data and MOVES model defaults, where needed. The fuel engine fractions were developed consistent with the local VMT mix estimate (e.g., no compressed natural gas (CNG) vehicles, no E-85 fuel type, and no gasoline transit buses were delineated in the VMT mix, which was reflected in the local fuel engine fractions estimates). Locality-specific SUT age distributions were produced based on the TxDMV county vehicle registration category aggregations, consistent with the vehicle registration category aggregations of the VMT mix (see Appendix B). Appendix H includes the age distributions and fuel engine fractions summaries.

Table 22 summarizes the data sources and aggregation levels used to estimate the San Antonio area county sourcetypeagedistributions and statewide fuel engine fractions.

Table 22. Sources and Aggregations for SUT Age Distributions and Fuel Engine Fractions.

SUT Name	SUT ID	TxDMV Category[1] Aggregations for Age Distributions and Fuel Engine Fractions	Geographic Aggregation for Age Distributions	Geographic Aggregation for Fuel Engine Fractions[2]
Motorcycle	11	Motorcycles	County	NA – 100 percent gas, no Fuel Engine Fractions
Passenger Car	21	Passenger	County	MOVES default[2]
Passenger Truck	31	Total Trucks<=8500	County	MOVES default[2]
Light Commercial Truck	32	Total Trucks<=8500	County	MOVES default[2]
Single Unit Short-Haul Truck	52	>8500+ >10000+ >14000+>16000	Multi-County Modeling Area	Texas Statewide
Single Unit Long-Haul Truck	53	>8500+ >10000+ >14000+>16000	Texas Statewide	Texas Statewide
Refuse Truck	51	MOVES default		
Motor Home	54			
Intercity Bus	41			
Transit Bus[2]	42			
School Bus	43			
Combination Short-Haul Truck	61	>19500+ >26000+ >33000+ >60000	Multi-County Modeling Area	Texas Statewide
Combination Long-Haul Truck	62	>19500+ >26000+ >33000+ >60000	Texas Statewide	NA – 100 percent diesel, no Fuel Engine Fractions

[1] TxDOT mid-year 2014 county vehicle registrations data (i.e., three-file data set: composite fuel light-duty categories; heavy-duty gasoline by eight weight categories; and heavy-duty diesel by eight weight categories) were used for developing local inputs (weights are GVWR in units of lbs.). The MOVES2014 model default age distributions were from the MOVESDB20141021 database.

[2] MOVES default fuel engine fractions for transit buses were revised to exclude the CNG and gasoline-fueled components, and light-duty categories were revised to exclude E-85 fuel type, consistent with the local vehicle type VMT mixes. MOVES2014 default fuel engine fractions were taken from the MOVESDB20141021 sample vehicle population table.

Local Meteorological (County and Zonemonthhour Table) Inputs to MOVES – The meteorological inputs, provided by TCEQ, were input via the "county" (barometric pressure) and "zonemonthhour" (temperature and relative humidity) tables. These county-level input data were developed as June 1 through August 31, 2014 hourly temperature and relative humidity, and 24-hour barometric pressure averages, using the aggregated hourly observations over this period from the available weather station data in each county. Altitude, also an input of the county table, was set to “low” for all counties. Appendix I summarizes the temperatures, relative humidity, and barometric pressure input values.

Fuels Inputs to MOVES – This description of the fuels inputs is discussed in the context of the overall AERR inventories project (i.e., for the larger geographic area where the San Antonio area counties are located). Both summer and winter season input data are discussed, as the winter data values were used, as described in a later section, in the estimation of annual emissions. As for the data used, the objective was to use suitable local survey data, where readily available, and other data, such as MOVES defaults, if needed.

For previous inventory analyses, TTI has in general used and/or developed fuel property inputs by aggregating expansive Texas fuel sample data (properties) by the 25 TxDOT districts (available in the TCEQ surveys), making boundary adjustments as needed to maintain consistency with each county’s fuel policies. To produce more stable and robust results from the somewhat limited, although not unsubstantial survey sample data sets, TTI modified the aggregation scheme from 25 districts to a higher level generally in line with applicable Texas fuel rule jurisdictions. The result is gasoline fuel property inputs based on the local TCEQ fuel survey data, estimated for six regions (consistent with the fuel regions for Texas used in MOVES 2014). The fuel regions are defined as follows:

Label	fuelregionid	Counties	Description
R1	300000000	132	Federal 9.0 RVP limit (waiver for E10), minus 11 southern counties labeled as R6;
R2	178010000	95	TxLED; State 7.8 RVP limit (no waiver for E10);
R3	370010000	1	El Paso 7.0 RVP (no waiver for E10);
R4	1370011000	12	TxLED; RFG;
R5	178000000	3	TxLED; Federal 7.8 RVP limit (waiver for E10); and
R6	100000000	11	Same as R1, but different distribution network.

Note that the fuel areas labeled as R1 through R5 represent the summertime gasoline fuel rules for Texas. Consistent with MOVES2014, a subset of the Texas federal 9.0 RVP limit counties (11 counties in the south end of Texas) is treated separately (per EPA OTAQ staff, due to their being supplied by a different distribution network; contrasts were noted in the comparison of R1 and R6 county gasoline sample values). Additionally, the R1, R3, and R6 regions are comprised solely of non-TxLED counties and the R2, R4, and R5 regions contain all TxLED counties.

The local fuels inputs to MOVES were input in the CDB fuelsupply and fuelformulation tables. The summer and winter season fuel supply for each county consisted of one average gasoline and one average diesel fuel formulation (and therefore gasoline and diesel fuel supply market share values were 1.0 for each). The data sources for the summer fuel formulations were local survey data; for winter, except for RFG and diesel, the MOVES E10 (conventional gasoline blended with 10% by volume ethanol) defaults were largely relied upon. TTI prepared the fuels input data in spreadsheets, saved them to text files, and imported these local fuels inputs to storage database tables (fuelformulation and fuelsupply), using IDs for the local fuel formulations outside the range of MOVES default fuel formulation IDs. County-fuel scenario data were selected from storage databases and inserted into the CDB fuelsupply and fuelformulation tables, as needed for input to MOVES emissions rate runs.

The following describes the procedure used to populate the CDB fuels tables for each CDB (county and year).

- Selected all MOVES default fuelsupply records associated with the county-fuel scenario (i.e., for the county's applicable MOVES fuelRegionID, and scenario's fuelyearID [analysis year] and monthgroupID [7 for July, or summer season fuel, or 1 for January, or winter season fuel]), inserted the data into the CDB fuelsupply table, and set the market share field values to zero. (This was to prevent MOVES from applying its default fuels data in addition to the desired local fuels input data).
- Selected the local fuel supply records for the county-fuel scenario from the local storage database (i.e., the fuel formulation market shares of the specified locally-developed fuel formulations for the analysis), and inserted the data into the CDB fuelsupply table.
- Selected all of the local fuel formulation records for the county-fuel scenario from the storage database, where stored fuelformulationID corresponded with the CDB fuelsupply table's fuelformulationID, fuelyearID, and monthgroupID, and inserted the data into the CDB fuelformulation table.

The MOVES2014 fuel property fields and units (of the fuelformulation table) are:

- RVP (psi);
- sulfurLevel (ppm);
- ETOHVolume (volume percent);
- MTBEVolume (volume percent);
- ETBEVolume (volume percent);
- TAMEVolume (volume percent);
- aromaticContent (volume percent);
- olefinContent (volume percent);
- benzeneContent (volume percent);
- e200 (vapor percent at 200 degrees Fahrenheit);
- e300 (vapor percent at 300 degrees Fahrenheit);
- T50 (degrees Fahrenheit at 50 percent vapor); and
- T90 (degrees Fahrenheit at 90 percent vapor).

Although not listed above the fields, BioDieselEsterVolume, CetaneIndex, and PAHContent are also included in the fuelformulation table, but were not used. Additionally, note that when the T50/T90 values are input to MOVES, as was the case in this analysis, they are used instead of E200/E300 values.

Data Sources – The EPA Office of Transportation and Air Quality (OTAQ) provided TTI with the 2014 Texas (Houston and Dallas) RFG retail outlet survey samples by fuel grade (summer and winter regular, mid-grade, and premium) collected by the RFG Survey Association.[9] Non-RFG county summer gasoline sample data, also by fuel grade, were acquired from the TCEQ summer 2014 fuel survey study (performed by ERG). For the non-RFG regions winter data, the MOVES defaults were relied upon, since no readily available local winter data were available. For estimating diesel sulfur levels, diesel sample data from the TCEQ summer 2014 survey were used for both summer and winter seasons.

Development of Gasoline Fuel Formulation Inputs from Local Survey Samples – Within each of the six fuel regions as defined previously, the sample data (by season in the case of the RFG data) were aggregated and averaged. The standard procedure was to calculate averages first by fuel grade (i.e., regular – RU, mid-grade – MU, and premium – PU), then to combine them in overall averages using weighting factors from relative sales volumes by fuel grade. The relative sales volumes were estimated using annual average sales volumes per day through retail outlet statistics for Texas.[10] For the winter formulations for the non-RFG counties, the MOVES default E10 formulations were used (but the fuel formulation IDs were changed).

Diesel Fuel Formulations – The diesel fuel formulation input consists basically of average sulfur content (currently biodiesel is treated as *de minimus*). (The effects of TxLED were incorporated by emissions factor post-processing, discussed later.) The diesel input values were estimated by aggregating the summer 2014 sample data within TxLED and non-TxLED regions and assigning the resulting averages to counties accordingly.

Table 23, Table 24, and Table 25 summarize the summer gasoline, winter gasoline, and diesel formulations, respectively. The San Antonio counties are represented in two fuel regions: Kendall County in the region labeled "R1," and the remaining four counties residing in the region labeled "R2" (see the table notes).

[9] For more background information see: http://www.epa.gov/otaq/fuels/gasolinefuels/rfg/properf/perfmeth.htm.

[10] Sales volumes by grade were from the Energy Information Administration's (EIA) Petroleum Marketing Annuals. 2011 sales (current latest available) were used to produce the 2014 average gasoline/RFG formulations.

Table 23. Summer 2014 Gasoline Fuel Formulation Inputs – Texas MOVES Fuel Regions.

MOVES Fuel Formulation Field	Units	Region[1, 2]					
		R1	R2	R3	R4	R5	R6
fuelFormulationID	-	10701	10702	10703	10704	10705	10706
fuelSubtypeID	-	12	12	12	12	12	12
RVP	psi	9.17	7.52	6.83	7.10	7.68	9.17
sulfurLevel	ppm	27.66	30.84	14.84	28.47	25.41	18.42
ETOHVolume	volume%	9.62	9.76	9.77	9.70	9.80	9.77
MTBEVolume	volume%	0	0	0	0	0	0
ETBEVolume	volume%	0	0	0	0	0	0
TAMEVolume	volume%	0	0	0	0	0	0
aromaticContent	volume%	20.92	22.65	25.79	14.42	25.86	15.67
olefinContent	volume%	10.20	11.75	8.39	13.36	6.59	16.53
benzeneContent	volume%	0.70	0.55	0.40	0.44	0.65	0.61
e200	vapor%	54.11	49.82	47.21	49.00	50.61	57.40
e300	vapor%	84.32	83.70	87.77	84.30	84.26	86.40
T50	degrees F	179.68	203.22	211.33	203.60	199.96	162.69
T90	degrees F	323.78	322.54	306.75	329.78	317.79	317.56

[1] The fuel region labels are defined as:

Label	fuelregionid	Counties	Description
R1	300000000	132	Federal 9.0 RVP limit (RVP waiver available for E10);
R2	178010000	95	State 7.8 RVP limit (no available RVP waiver);
R3	370010000	1	El Paso 7.0 RVP (no RVP waiver);
R4	1370011000	12	RFG;
R5	178000000	3	Federal 7.8 RVP limit (RVP waiver available for E10); and
R6	100000000	11	Same as R1, except a different distribution network (per EPA OTAQ).

[2] TTI produced these fuel formulation estimates using local summer 2014 fuel survey sample data (TCEQ survey by ERG for non-RFG counties and EPA Texas RFG survey data). The overall average fuel properties for each region were calculated using the standard procedure of aggregating and averaging by fuel grade (regular [RU], mid-grade [MU], and premium [PU]), and combining them into the final overall averages using latest available statewide gasoline relative sales volumes by grade (U.S. Energy Information Administration: RU – 0.88; MU – 0.062; PU – 0.058).

Table 24. Winter 2014 Gasoline Fuel Formulation Inputs – Texas Fuel Regions.

MOVES Fuel Formulation Field	Units	Region[1, 2]		
		R1, R3	R2, R5, R6	R4
fuelFormulationID	-	13101	13067	10104
fuelSubtypeID	-	12	12	12
RVP	psi	11.61	12.07	10.85
sulfurLevel	ppm	30	30	35.09
ETOHVolume	volume%	10	10	10.09
MTBEVolume	volume%	0	0	0
ETBEVolume	volume%	0	0	0
TAMEVolume	volume%	0	0	0
aromaticContent	volume%	22.05	19.29	13.86
olefinContent	volume%	7.05	10.46	11.02
benzeneContent	volume%	0.63	0.61	0.47
e200	vapor%	53.74	54.3	58.39
e300	vapor%	87.4	83.59	86.61
T50	degrees F	194.22	186.68	155.64
T90	degrees F	310.28	326.93	317.30

[1] The fuel region labels are defined as:

Label	fuelregionid	Counties	Description
R1	300000000	132	Federal 9.0 RVP limit (RVP waiver available for E10);
R2	178010000	95	State 7.8 RVP limit (no available RVP waiver);
R3	370010000	1	El Paso 7.0 RVP (no RVP waiver);
R4	1370011000	12	RFG;
R5	178000000	3	Federal 7.8 RVP limit (RVP waiver available for E10); and
R6	100000000	11	Same as R1, except a different distribution network (per EPA OTAQ).

[2] TTI produced the RFG fuel formulation estimates using local winter 2014 fuel survey sample data (EPA Texas RFG survey data), except for RVP, which is the MOVES default (RVP is not available in the EPA winter RFG data). RFG properties were calculated using the standard procedure of aggregating and averaging by fuel grade (regular [RU], mid-grade [MU], and premium [PU]), and combining them into the final overall averages using latest available statewide sales volumes by grade (U.S. Energy Information Administration: RU – 0.88; MU – 0.062; PU – 0.058). In the absence of recent winter survey data for non-RFG counties, MOVES default formulations were used for the non-RFG counties.

Table 25. 2014 Diesel Fuel Formulation Estimates – Texas MOVES Fuel Regions.

MOVES Fuel Formulation Field	Units	Region[1, 2]	
		R1, R3, R6	R2, R4, R5
fuelFormulationID	-	30001	30002
fuelSubtypeID	-	20	20
RVP	-	0	0
sulfurLevel	ppm	3.56	6.18
ETOHVolume	-	0	0
MTBEVolume	-	0	0
ETBEVolume	-	0	0
TAMEVolume	-	0	0
aromaticContent	-	0	0
olefinContent	-	0	0
benzeneContent	-	0	0
e200	-	0	0
e300	-	0	0
BioDieselEsterVolume	-	\N	\N
CetaneIndex	-	\N	\N
PAHContent	-	\N	\N
T50	-	0	0
T90	-	0	0

[1] The fuel region labels are defined as:

Label	fuelregionid	Counties	Description
R1	300000000	132	Federal 9.0 RVP limit (RVP waiver available for E10);
R2	178010000	95	State 7.8 RVP limit (no available RVP waiver); TxLED;
R3	370010000	1	El Paso 7.0 RVP (no RVP waiver);
R4	1370011000	12	RFG; TxLED;
R5	178000000	3	Federal 7.8 RVP limit (RVP waiver available for E10); TxLED; and
R6	100000000	11	Same as R1, except a different distribution network (per EPA OTAQ).

[2] TTI produced diesel average sulfur estimates using the summer 2014 TCEQ fuel survey diesel sample data by aggregating and averaging sulfur content values for TxLED (R2, R4, and R5) counties and non-TxLED (R1, R3, and R6) counties.

Local I/M Inputs to MOVES – Not applicable.

The MOVES input files (MRSs and CDBs) were provided as a part of the electronic data submittal (Appendix A) of this Technical Note.

Checks and Runs

After completing the input data preparation, the CDBs were checked to verify that all 20 tables were in the CDBs and the tables were populated with data as intended. The MOVES RunSpecs were run in batches using the MOVES command line tool. The batches were designed to write each MOVES run log to a text file for subsequent error/warning checking, of which none were found. The MOVES run summaries are included as Appendix J.

Post-Processing Runs

Each MOVES output database was post-processed using a two-step process – for each county and year, an interim RatesCalc rate database was produced, followed by the final rates RatesAdj database containing the emissions rate tables for input to the emissions inventory calculations. The following post-processing steps were performed on each MOVES output database. See the utility descriptions in Appendix B for more information.

- RatesCalc – Interim Rates Databases: Using RatesCalc, the mass/SHP off-network evaporative process rates were calculated using data from the CDB, the MOVES default database, and the MOVES rateperprofile and ratepervehicle emissions rate output. The utility also copied the mass/mile, mass/start, and mass/hour rates along with the units into emissions rate tables. This utility does not perform any unit conversions, and excludes total energy and refueling processes. It created an output database containing the rates tables input to the RatesAdj utility. In addition to a table containing the run information and one with the activity data, there were four emissions rate look-up tables produced: ttirateperdistance, ttirateperstart, ttirateperhour (for extended idle and auxiliary power exhaust), and ttiratepershp.
- RatesAdj – Final Rate Databases: Using RatesAdj, TTI produced the final emissions rates for input to the EmsCalc emissions calculator. RatesAdj extracted emissions rates from the RatesCalc rate tables for only those pollutants needed in the emissions calculations, and applied TxLED adjustments (see factors in Table 26) to the diesel vehicle NO_x emissions rates for all TxLED counties (all five San Antonio area counties except Kendall). The ratesadj output databases, one for each county created for input to the emissions calculations, contain a ratesadjrun table of utility execution information, and the four emissions rate tables: ttirateperdistance, ttirateperstart, ttirateperhour, and ttiratepershp.

See Appendix B for more information on the TTI MOVES on-road rates development utilities.

NO_x Adjustment for TxLED Effects

TTI produced the TxLED NO_x adjustment factors shown in Table 26 using a TCEQ procedure that produces each diesel-powered SUT's average adjustment factor as a combination of a 4.8% reduction for the 2002 and newer model year vehicles and a 6.2% reduction for the 2001 and older model year vehicles.[11]

The procedure involves MOVES runs that produce by-model year output data that are processed in a spreadsheet to calculate the aggregate, average NO_x adjustment factors (across all model years). The resulting average NO_x adjustment factors (by diesel SUT and calendar year of evaluation) are especially sensitive to the age distributions and calendar year inputs, which directly affect the relative NO_x emissions contributions between the earlier and later model year groups. Statewide age distribution estimates were based on the mid-year (2014) statewide TxDMV vehicle registrations data.

Table 26. 2014 TxLED Reduction Factors.

Diesel Fuel Source Use Type	Reduction	Adjustment[1] Factor
Passenger Car	5.61%	0.9439
Passenger Truck	5.27%	0.9473
Light Commercial Truck	5.60%	0.9440
Intercity Bus	5.81%	0.9419
Transit Bus	5.77%	0.9423
School Bus	5.77%	0.9423
Refuse Truck	5.56%	0.9444
Single Unit Short-Haul Truck	5.00%	0.9500
Single Unit Long-Haul Truck	4.99%	0.9501
Motor Home	5.53%	0.9447
Combination Short-Haul Truck	5.35%	0.9465
Combination Long-Haul Truck	5.46%	0.9454

[1] Source: Developed by TTI using the TCEQ procedure and MOVES2014 October Release.

Appendix A describes the electronic data submittal for this inventory analysis, which includes the MRS files, CDBs, TxLED adjustment factor files used and calculation spreadsheets, and the final adjusted emissions rate look-up database table inputs to the emissions calculations.

[11] "Memorandum: Texas Low Emission Diesel (LED) Fuel Benefits." To Karl Edlund, EPA, Region VI, from Robert Larson, EPA, Office of Transportation and Air Quality (OTAQ), National Vehicle and Fuel Emissions Laboratory at Ann Arbor, Michigan. September 27, 2001.

SUMMER WEEKDAY EMISSIONS CALCULATIONS

TTI calculated hourly, summer weekday, link-based emissions inventories by county for each year using the EmsCalc utility. Emissions calculations fall into two categories: VMT-based and off-network. The VMT-based emissions calculations use the roadway-based rates and the TDM-based VMT and speeds to estimate emissions at the TDM network link (or roadway segment) level. The off-network emissions process calculations use off-network rates and off-network activity (SHP, starts, SHI, and APU hours) to estimate emissions at the county level.

EmsCalc output for each county and year included three files: a listing file (of run execution information), a standard tab-delimited inventory summary (with both hourly and 24-hour summary tables), and a tab-delimited 24-hour inventory summary by SCC. The county SCC inventory summaries for each year were input to TTI's MOVESsccXMLformat utility, which converted them into an EPA CERS XML inventory format for each year for loading in TCEQ's TexAER.

Hourly Link-Based Emissions Calculations

The county, analysis year, summer weekday, hourly emissions were calculated with the EmsCalc utility using the following major inputs:

- Vehicle type VMT mix – TxDOT district-level, weekday, by MOVES roadway type for four time-of-day periods;
- Time period designation – the four VMT mix time periods to hour-of-day associations;
- Roadway-based activity – link (and intrazonal link)-specific, hourly, directional, operational VMT and speed estimates as developed by the TRANSVMT utility to include: A-node, B-node, county number, TDM road type (functional class) code, link length, congested (operational) speed, VMT, and TDM area type code;
- Roadway-based emissions factors – MOVES-based, county level by pollutant, process, hour, average speed, MOVES road type, SUT, and fuel type;
- Off-network activity – county, hourly SHP, starts, SHI, and APU hours by vehicle type;
- Off-network (parked vehicle) emissions factors – MOVES-based, county level by pollutant, process, hour, SUT, and fuel type;
- TDM road type designations – TDM road type and area type codes to MOVES road type codes (and to VMT mix road type, and to rates road type codes) (see Table 27); and
- On-road SCCs – from the MOVES2014 default database corresponding to MOVES SUT, fuel type, road type, and emissions process categories.

The VMT-based emissions were calculated for each hour using the TxDOT district-level vehicle type VMT mix with time period-to-hour designations, the TDM link and intrazonal link VMT and speeds estimates, the MOVES-based "on-network" emissions factors, and the TDM road type/area type to MOVES road types designations. For each link, the link was assigned a MOVES road type (and VMT mix road type and rates road type, which for this analysis were the same as the MOVES road type) based on the link's road type and area type. The link VMT was then distributed to each vehicle type using the appropriate VMT mix, based on the link's designated VMT mix road type, its associated TxDOT district, and time-of-day period to hour-of-day designation.

The emissions factors for each vehicle type for each hour were selected based on the link's designated rates road type code (same as the MOVES road type code) and the link speed. For link speeds falling between the MOVES speed bin average speeds, emissions factors were interpolated from the bounding speeds. For link speeds falling outside of the MOVES speed range (less than 2.5 mph and greater than 75 mph), the emissions factors for the associated bounding speeds were used. For each pollutant and process, the mass/mile rates were multiplied by the link VMT producing the link-level emissions estimates for each vehicle type.

Table 27. San Antonio TDM Road Type/Area Type to MOVES Road Type Designations.

TDM Road Type (Code - Name)[1]	TDM Area Type (Code - Name)[1]	MOVES Road Type (Code - Name)[1, 2]
1 - Radl IH Fwy ML	5 - Rural	2 – Rural Restricted Access
3 - Circ IH Fwy ML		
5 - Radl Oth Fwy ML		
7 - Circ Oth Fwy ML		
9 - Radial Expressways		
10 - Circ. Expressways		
22 - Ramp (Fwy-to-Fwy)		
0 - Local (Cent Conn)	5 - Rural	3 – Rural Unrestricted Access
11 - Prin Art Div		
12 - Prin Art CLT Lane		
13 - Prin Art Undiv		
14 - Min Art Div		
15 - Min Art CLT Lane		
16 - Min Art Undiv		
17 - Coll Div		
18 - Coll CLT Lane		
19 - Coll Undiv		
20 - Frontage Road		
21 - Ramp (Between FR/ML)		
1 - Radl IH Fwy ML	1 - CBD	4 – Urban Restricted Access
3 - Circ IH Fwy ML	2 - CBD Fringe	
5 - Radl Oth Fwy ML	3 - Urban	
7 - Circ Oth Fwy ML	4 - Suburban	
9 - Radial Expressways		
10 - Circ. Expressways		
22 - Ramp (Fwy-to-Fwy)		
0 - Local (Cent Conn)	1 - CBD	5 – Urban Unrestricted Access
11 - Prin Art Div	2 - CBD Fringe	
12 - Prin Art CLT Lane	3 - Urban	
13 - Prin Art Undiv	4 - Suburban	
14 - Min Art Div		
15 - Min Art CLT Lane		
16 - Min Art Undiv		
17 - Coll Div		
18 - Coll CLT Lane		
19 - Coll Undiv		
20 - Frontage Road		
21 - Ramp (Between FR/ML)		
40 - Local (Intrazonal)	40 - Local (Intrazonal)	

[1] The TDM road type and area type code combinations are also correlated to VMT mix road type codes and emissions rate road type codes, which, for this analysis, are identical to the MOVES road type codes.

[2] The four period, time-of-day VMT mix to hour-of-day designations are: AM peak – three hours of 6 a.m. to 9 a.m.; mid-day – seven hours of 9 a.m. to 4 p.m.; PM peak – three hours of 4 p.m. to 7 p.m.; and overnight – 11 hours of 7 p.m. to 6 a.m.

The off-network emissions were calculated for each hour using the hourly MOVES-based off-network emissions factors by vehicle type and the county-level hourly vehicle type off-network activity estimates (SHP, starts, SHI, and APU hours). The emissions factors were multiplied by the appropriate off-network activity, as determined by the pollutant process-activity association (shown previously in Table 7).

The EmsCalc utility outputs for the analysis consist of the listing file (summarizing information regarding running the utility), the standard tab-delimited inventory report summary file including both hourly and 24-hour activity and pollutant process emissions estimates by vehicle type and TDM road type, and the MOVES SCC tab-delimited 24-hour inventory report summary.

Conversion of Emissions Inventories to XML Format

TTI converted the 24-hour emissions and activity results for each year to a format compatible for uploading to the TCEQ's TexAER – based on the EPA's EIS NEI CERS XML format, which uses EPA's EIS inventory data codes, except that the new SCCs and the NEI pollutant codes available in the MOVES2014 default database (MOVESdb20141021) "scc" and "pollutant" tables were used. To make the conversion of the EmsCalc utility's SCC-based inventory output to the specified XML format, TTI used its MOVESsccXMLformat utility and the following inputs:

- Pollutants file – list of input pollutant labels (as written in the EmsCalc SCC-based inventory file to be processed, e.g., "Pounds of CO Emissions"), and corresponding EIS pollutant codes (e.g., "CO") and units codes (e.g., "LB") for each pollutant to be included in the XML output;
- XML header input file – specifies the data used in the header portion of the XML output file, along with the reporting period and the VMT units; and
- Inventory data files to be converted – one EmsCalc-produced, MOVES SCC-based, 24-hour emissions inventory summary file for each county to be included in the XML file. Contains a county code record and the following fields: SCC, Activity Type, and Activity followed by an emissions field for each pollutant using field headers labeled consistent with the EmsCalc emissions summary tables (e.g., Pounds of CO Emissions, Pounds of PM10_Total_Exh Emissions, and Pounds of PM10_Brakewear Emissions).

The SCCs are 10 digits, composed of "22" (code for on-road mobile source) followed respectively by the four, two digit MOVES category IDs: fuelTypeID, sourceTypeID, roadTypeID, and processID. Thus, all these dimensions were retained in the XML inventory summary, although off-network activity codes were not available. In the absence of EIS codes for off-network activity, the practice of coding these activity types (SHP, starts, SHI, and APU hours) as "VMT" with their values set to zero was applied. The pollutants included in the XML files were: VOC, CO, NO_x, SO_2, NH_3, $PM_{2.5}$, PM_{10} (exhaust, tirewear and brakewear), and CO_2.

Each run produced a LST file (execution information, input/output file listings, input summaries, and input and output totals summaries with calculated differences for QA checks), the XML file, and one XML output summary of SCC-labeled inventory data in a tab-delimited text file form for each county included in the run. All these files were included in the electronic data submittal (Appendix A).

ANNUAL ACTIVITY AND EMISSIONS

Two of the main components of the summer weekday emissions are activity and emissions rates. To incorporate seasonal changes in both the activity and emissions rates, activity and emissions rate annualization factors were used in the annualization methodology.

The activity annualization factors consist of a VMT annualization factor, a hotelling hours annualization factor (used for SHI and APU hours), starts annualization factors by SUT, and SHP annualization factors by SUT. These factors were used to convert the seasonal weekday activity component of the emissions and to annualize the summer weekday activity.

The emissions rate annualization factors by pollutant, process, SUT, fuel type, and aggregate road type (restricted access, unrestricted access, off-network) are calculated from MOVES inventory mode runs. These factors were needed to accommodate changes in emissions rates between the summer weekday season and the remainder of the year due to the variation in various seasonal parameters.

Generally, the summer weekday activity was annualized by applying the appropriate activity annualization factor to the summer weekday activity and the summer weekday emissions were annualized by applying the appropriate activity annualization factor and emissions rate annualization factor to the summer weekday emissions. In some cases, emissions rate annualization factors do not exist (mainly due to emissions existing in some seasons but not in summer weekday). In these cases, the annual emissions are calculated by multiplying the annual emissions rate (from the emissions rate annualization factor procedures) by the annual activity.

Annual Activity and Annualization Factors

To estimate the annual emissions and build the annual MOVES inventory mode databases (discussed in a later section) in a consistent manner (i.e., annualized summer weekday activity is closely replicated by a MOVES inventory mode run), the summer weekday activity (VMT, hotelling hours, starts, and SHP) was converted to annual activity based on the MOVES calculation procedures to a format suitable for use with the MOVES inventory mode. This annual activity was then used to construct the activity annualization factors that were applied during the annual emissions estimation process.

Annual VMT and Annualization Factors

The MOVES calculation procedure for VMT allocates annual VMT by the MOVES defined HPMS vehicle types to summer weekday VMT by HPMS vehicle type using month VMT fractions, day VMT fractions, number of days in the month, and the number of days in the period for the day VMT fraction. The formula for the MOVES VMT allocation procedure is:

$$SWkdVMT_{HPMSVtype} = AVMT_{HPMSVtype} * monthFract_{Month} * dayFract_{Month,DayType} / (noOfDays/7) / noOfRealDays$$

Where:

$SWkdVMT_{HPMSVtype}$	=	summer weekday VMT by HPMS vehicle type;
$AVMT_{HPMSVtype}$	=	annual VMT by HPMS vehicle type;
$monthFract_{Month}$	=	month VMT fraction for the desired month;
$dayFract_{Month,DayType}$	=	day VMT fraction for the desired day type (weekday or weekend day by month);
noOfDays	=	number of days in the desired month; and
noOfRealDays	=	number of days in the desired day type (5 for weekday, 2 for weekend day).

Since the objective is to estimate annual VMT from the summer weekday VMT, the formula from the MOVES VMT allocation procedure can be transformed to calculate the annual VMT from the summer weekday VMT by reversing the calculations. The formula for calculating the annual VMT by HPMS vehicle type from the summer weekday VMT is:

$$AVMT_{HPMSVtype} = SWkdVMT_{HPMSVtype} * noOfRealDays *(noOfDays/7) / dayFract_{Month,DayType} / monthFract_{Month}$$

The number of days in the day type (noOfRealDays) and number of days in the month (noOfDays) are determined by the emissions inventory being annualized. Since the inventories are for summer (July) weekday, the number of days in the day type was set to 5 and the number of days in the month was set to 31. Day VMT fractions and month VMT fractions were developed by TxDOT district using aggregated ATR data (years 2004 - 2013). See Appendix K for the day VMT fractions and the month VMT fractions. For each county, this calculation procedure was applied to the summer weekday VMT for each HPMS vehicle type (output from the MOVESactivityInputBuild utility, see Appendix A) and saved for use in building the annual MOVES inventory mode databases.

The county-level VMT annualization factor was then calculated by dividing the county total annual VMT by the county total summer weekday VMT. Table 28 shows the summer weekday VMT, annual VMT and VMT annualization factors.

Table 28. Annual VMT, Summer Weekday, VMT and VMT Annualization Factors.

County	Annual VMT	Summer Weekday VMT	VMT Annualization Factor
Bexar	15,515,284,236	43,946,656	353.048
Comal	1,642,062,813	4,651,102	353.048
Guadalupe	1,391,112,326	3,940,291	353.048
Kendall	404,558,899	1,145,903	353.048
Wilson	471,568,844	1,335,707	353.048

Annual Hotelling Hours and Annualization Factors

The annual hotelling hours were calculated using similar logic and input parameters as the VMT annualization procedure. Since the hotelling hours input to MOVES is required by age, the hourly summer weekday hotelling hours (from the emissions inventory development process) was distributed to each age category using travel fractions. The hourly summer weekday hotelling hours by age was then converted to hourly annual hotelling hours by age. The hourly annual hotelling hours by age was then converted to the proper format for use with the MOVES inventory mode databases (hotelling hours by month, day type, hour, and age). The county total annual hotelling hours were then used to calculate the hotelling annualization factor, which was used during the emissions annualization process to annualize the SHI and APU hours activity.

Travel fractions were used to distribute the hourly summer weekday hotelling hours to each of the MOVES age categories. These travel fractions were calculated using the county-specific age distribution for SUT 62 (also used in the MOVES emissions rate runs) and the county-specific relative mileage accumulation rates (adjusted to reflect the VMT mix in the summer weekday emissions inventory) for SUT 62. The travel fractions by age were calculated by multiplying the age distribution by the relative mileage accumulation rates for each age and dividing by the sum of the product for all the age categories. The travel fractions were calculated using the following formula:

$$TF_{Age} = (STAD_{Age} * RelMAR_{Age}) / \sum(STAD_{Age} * RelMAR_{Age})$$

Where:

TF_{Age}	=	the travel fractions by age category;
$STAD_{Age}$	=	source type age distribution for SUT 62 by age;
$RelMAR_{Age}$	=	relative mileage accumulation rates by age (adjusted to reflect the VMT mix in the summer weekday emissions inventory) for SUT 62 by age; and
$\sum$ ( )	=	sum of ($STAD_{Age}$ * $RelMAR_{Age}$) across all age categories.

The travel fractions were then used to calculate the hourly summer weekday hotelling hours by age from the hourly summer weekday hotelling hours used in the emissions inventory development process. The hourly summer weekday hotelling hours by age were calculated using the following formula:

$$SWkdHH_{Hour,Age} = SWkdHH_{Hour} * TF_{Age}$$

Where:

$SWkdHH_{Hour,Age}$	=	hourly summer weekday hotelling hours by age;
$SWkdHH_{Hour}$	=	hourly summer weekday hotelling hours from the emissions inventory development process; and
TF_{Age}	=	the travel fractions by age category.

The hourly annual hotelling hours by age are then calculated using a similar procedure to the annual VMT using the day and month fractions (see Appendix K):

$$AHH_{Hour,Age} = SWkdHH_{Hour,Age} * noOfRealDays * (noOfDays/7) / dayFract_{Month,DayType} / monthFract_{Month}$$

Where:

$AHH_{Hour,Age}$	=	hourly annual hotelling hours by age;
$SWkdHH_{Hour,Age}$	=	hourly summer weekday hotelling hours by age;
NoOfRealDays	=	number of days in the desired day type – 5 for summer weekday;
noOfDays	=	number of days in the desired month – 31 for summer (July) weekday;
$dayFract_{Month,DayType}$	=	day VMT fraction for summer (July) weekday (see Appendix K); and
$monthFract_{Month}$	=	month VMT fraction for summer (July, See Appendix K).

Since the annual MOVES inventory mode databases also require the hotelling hours input for each month and day type (weekday and weekend day) portions of the week, the annual hotelling hours by age were calculated for each month and day type period (total of 24 sets of hotelling hours) using the following formula:

$$HH_{Month,DayPeriod,Hour,Age} = AHH_{Hour,Age} * monthFract_{Month} * dayFract_{Month,DayType} / (noOfDays/7)$$

Where:

$HH_{Month,DayPeriod,Hour,Age}$	=	hotelling hours by month, day type period, hour, and age;
$AHH_{Hour,Age}$	=	hourly annual hotelling hours by age;
$monthFract_{Month}$	=	month VMT fraction (See Appendix K);
$dayFract_{Month,DayType}$	=	day VMT fraction (see Appendix K); and
noOfDays	=	number of days in the month (see Appendix K).

The hotelling annualization factor was then calculated by dividing the county total hotelling hours by the county total summer weekday hotelling hours. This hotelling annualization factor was used for annualizing the SHI and APU hours activity in the emissions annualization process. Table 29 shows the annual hotelling hours, summer weekday hotelling hours, and annualization factors.

Table 29. Annual Hotelling Hours, Summer Weekday Hotelling Hours and Annualization Factors.

County	Annual	Summer Weekday	Annualization Factor
Bexar	2,388,862	6,766	353.048
Comal	432,343	1,225	353.048
Guadalupe	129,501	367	353.048
Kendall	55,468	157	353.048
Wilson	10,392	29	353.048

Annual Starts and Annualization Factors

The annual starts inputs to MOVES require starts by month, portion of the week (weekday portion and weekend day portion), hour, SUT, and age. These annual starts were calculated based on the summer weekday starts from the emissions inventory development process. The annual starts were also used, along with the summer weekday starts, to calculate county-level starts annualization factors by SUT.

In the emissions inventory development process, summer weekday starts were calculated by hour, SUT, and fuel type using the MOVES default weekday starts per vehicle. Since the MOVES default starts-per-vehicle do not vary by fuel type, all calculations were performed by SUT. To calculate the annual starts from the summer weekday starts, the starts for a summer weekend day must be calculated. This calculation was performed using weekend day equivalency factors, which were calculated by dividing the hourly MOVES default weekend day starts-per-vehicle by the hourly MOVES default weekday starts-per-vehicle. These equivalency factors were calculated using the formula:

$$WEDSEF_{Hour,SUT} = WEDSPV_{Hour,SUT} / WKDSPV_{Hour,SUT}$$

Where:

$WEDSEF_{Hour,SUT}$	=	weekend day starts equivalency factors by hour and SUT;
$WEDSPV_{Hour,SUT}$	=	MOVES default weekend day starts-per-vehicle by hour and SUT; and
$WKDSPV_{Hour,SUT}$	=	MOVES default weekday starts-per-vehicle by hour and SUT.

These equivalency factors were then used to convert the summer weekday starts from the emissions inventory development process to summer weekend day starts. The hourly summer weekday starts (by SUT and fuel type) were aggregated by SUT to produce hourly summer weekday starts by SUT and the equivalency factors were applied to calculate the summer weekend day starts by SUT. The summer weekend day starts were calculated using the following formula:

$$WEDS_{Hour,SUT} = WKDS_{Hour,SUT} * WEDSEF_{Hour,SUT}$$

Where:

$WEDS_{Hour,SUT}$	=	summer weekend day starts by hour and SUT;
$WKDS_{Hour,SUT}$	=	summer weekday starts by hour and SUT; and
$WEDSEF_{Hour,SUT}$	=	weekend day starts equivalency factors by hour and SUT.

MOVES requires starts by portion of the week (weekday portion and weekend portion), which means the summer weekday and summer weekend day starts by hour and SUT must be converted to portion of the week. This conversion is performed using the number of days in the portion of week (5 for weekday, 2 for weekend day). The following formula was used to convert both the summer weekday and summer weekend day starts to portions of the week:

$$Starts_{Week\ Portion,Hour,SUT} = DailyStarts_{Day\ Type,Hour,SUT} * noOfRealDays$$

Where:

$Starts_{Week,Hour,SUT}$	=	starts by portion of the week, hour, and SUT;
$DailyStarts_{Hour,SUT}$	=	daily starts by day type, hour, and SUT (summer weekday and summer weekend day); and
noOfRealDays	=	number of days in the portion of the week (5 for weekday, 2 for weekend day).

Since the MOVES default starts-per-vehicle and the vehicle population used to calculate starts do not vary by month, the starts for each month were set equal to the summer weekday portion of the week and summer weekend day portion of the week starts by hour and SUT, which completes the data set required for the MOVES inventory mode database. To calculate the starts annualization factors by SUT, the annual starts by SUT must be calculated. Since the monthly starts are by portion of the week, weekly starts by SUT are calculated for each month by summing the portion of the week starts, and the weekly starts by SUT are converted to monthly starts by SUT. These monthly starts were then summed to obtain the annual starts by SUT using the following formula:

$$AStarts_{SUT} = \sum[WStarts_{Month,SUT} *(noOfDays/7)]$$

Where:

$AStarts_{SUT}$	=	annual starts by SUT;
$WStarts_{Month,SUT}$	=	weekly starts by month and SUT;
noOfDays	=	number of days in the month (see Appendix K); and
$\sum [\ ]$	=	sum of the monthly starts.

The second component of the starts annualization factors by SUT is the summer weekday starts by SUT. The summer weekday starts by hour and SUT used in the emissions inventory development process were aggregated across hours and fuel types for each SUT to produce summer weekday starts by SUT. The annual starts by SUT were then divided by the summer weekday starts by SUT to produce the starts annualization factors by SUT. Table 30 and Table 31 show the starts annualization factors by SUT.

Table 30. Annual Starts, Summer Weekday Starts and Annualization Factors.

sourceTypeID	Bexar County			Comal County			Guadalupe County		
	Annual	Daily	Factor	Annual	Daily	Factor	Annual	Daily	Factor
11	6,797,519.55	11,137.20	610.34	6,797,519.55	11,137.20	610.34	6,797,519.55	11,137.20	610.34
21	1,725,166,917.12	4,824,754.24	357.57	1,725,166,917.12	4,824,754.24	357.57	1,725,166,917.12	4,824,754.24	357.57
31	467,347,277.41	1,340,563.63	348.62	467,347,277.41	1,340,563.63	348.62	467,347,277.41	1,340,563.63	348.62
32	128,333,114.39	368,423.26	348.33	128,333,114.39	368,423.26	348.33	128,333,114.39	368,423.26	348.33
41	140,254.66	461.54	303.88	140,254.66	461.54	303.88	140,254.66	461.54	303.88
42	570,762.17	1,547.55	368.82	570,762.17	1,547.55	368.82	570,762.17	1,547.55	368.82
43	1,540,686.72	5,315.26	289.86	1,540,686.72	5,315.26	289.86	1,540,686.72	5,315.26	289.86
51	905,546.28	3,066.39	295.31	905,546.28	3,066.39	295.31	905,546.28	3,066.39	295.31
52	32,452,751.72	113,816.78	285.13	32,452,751.72	113,816.78	285.13	32,452,751.72	113,816.78	285.13
53	2,188,738.75	7,259.08	301.52	2,188,738.75	7,259.08	301.52	2,188,738.75	7,259.08	301.52
54	131,618.01	360.25	365.35	131,618.01	360.25	365.35	131,618.01	360.25	365.35
61	10,599,450.13	36,785.70	288.14	10,599,450.13	36,785.70	288.14	10,599,450.13	36,785.70	288.14
62	8,835,576.27	30,259.71	291.99	8,835,576.27	30,259.71	291.99	8,835,576.27	30,259.71	291.99

Table 31. Annual Starts, Summer Weekday Starts and Annualization Factors.

sourceTypeID	Kendall County			Wilson County		
	Annual	Daily	Annual	Daily	Annual	Daily
11	317,700.54	520.53	317,700.54	520.53	317,700.54	520.53
21	48,221,053.09	134,859.26	48,221,053.09	134,859.26	48,221,053.09	134,859.26
31	17,941,343.24	51,463.90	17,941,343.24	51,463.90	17,941,343.24	51,463.90
32	4,926,675.66	14,143.68	4,926,675.66	14,143.68	4,926,675.66	14,143.68
41	12,408.41	40.83	12,408.41	40.83	12,408.41	40.83
42	50,495.65	136.91	50,495.65	136.91	50,495.65	136.91
43	136,305.42	470.24	136,305.42	470.24	136,305.42	470.24
51	80,114.19	271.29	80,114.19	271.29	80,114.19	271.29
52	2,871,113.22	10,069.43	2,871,113.22	10,069.43	2,871,113.22	10,069.43
53	193,638.95	642.22	193,638.95	642.22	193,638.95	642.22
54	11,644.32	31.87	11,644.32	31.87	11,644.32	31.87
61	271,063.32	940.73	271,063.32	940.73	271,063.32	940.73
62	798,844.07	2,735.85	291.99	1,422,145.98	4,870.51	291.99

Annual SHP and Annualization Factors

The annual SHP required to calculate SHP annualization factors was calculated using a process very similar to MOVES. This annual SHP was then used, along with the summer weekday SHP, to calculate SHP annualization factors. All calculations were performed for each county.

The first step in calculating annual SHP is to calculate the SUT vehicle population by age using the source type age distribution. Following is the formula used to calculate the SUT vehicle population by age:

$$VehPop_{SUT,Age} = VehPop_{SUT} * AgeDist_{SUT,Age}$$

Where:

$VehPop_{SUT,Age}$	=	vehicle population by SUT and age;
$VehPop_{SUT}$	=	vehicle population by SUT; and
$AgeDist_{SUT,Age}$	=	source type age distribution by SUT and age.

The next step in calculating the annual SHP is to calculate the vehicle population within each MOVES designated HPMS vehicle class. Each SUT in the vehicle population by SUT is assigned an HPMS vehicle class and the vehicle population is summed for each HPMS vehicle type.

The next step in calculating the annual SHP is to calculate the vehicle population fractions within each HPMS vehicle class. For each SUT, the vehicle population by SUT and age is assigned an HPMS vehicle class and divided by the appropriate HPMS vehicle class. Following is the formula for calculating the vehicle population fractions within each HPMS vehicle class:

$$HVehFract_{SUT,Age} = VehPop_{SUT,Age} / VehPop_{HPMSvtype}$$

Where:

$HVehFract_{SUT,Age}$	=	vehicle population fractions within each HPMS vehicle class by SUT and age,
$VehPop_{SUT,Age}$	=	vehicle population by SUT and age, and
$VehPop_{HPMSvtype}$	=	vehicle population by HMPS vehicle type.

The next step in calculating the annual SHP is to calculate the travel fractions by SUT and age. These travel fractions, which represent the amount of travel by SUT and age within each HPMS vehicle type, were calculated by multiplying the vehicle population fractions within each HPMS vehicle class (SUT and age) by the relative mileage accumulation rates (SUT and age) and divided by the sum of the product by HPMS vehicle type. The relative mileage accumulation rates were adjusted to reflect the 24-hour VMT mix contained in the summer weekday activity and emissions. Following is the formula for calculating the travel fractions by SUT and age:

$$TF_{SUT,Age} = HVehFract_{SUT,Age} * relMAR_{SUT,Age} / \sum(HVehFract_{SUT,Age} * relMAR_{SUT,Age})_{HPMSvtype}$$

Where:

$TF_{SUT,Age}$	=	travel fraction by SUT and age;
$HVehFract_{SUT,Age}$	=	vehicle population fractions within each HPMS vehicle class by SUT and age;
$relMAR_{SUT,Age}$	=	relative mileage accumulation rates by SUT and age; and
$\sum ( )$	=	sum of ($HVehFract_{SUT,Age}$ * $relMAR_{SUT,Age}$) across HPMS vehicle type.

The annual VMT by road type, SUT, and age was then calculated by multiplying the annual VMT by HPMS vehicle type (from the VMT annualization process described previously), the road type distribution by SUT and road type, and the travel fractions. Following is the formula for calculating the annual VMT by road type, SUT, and age:

$$AVMT_{RoadType,SUT,Age} = AVMT_{HPMSVtype} * RDIST_{SUT,RoadType} * TF_{SUT,Age}$$

Where:

$AVMT_{RoadType,SUT,Age}$	=	annual VMT by road type, SUT, and age;
$AVMT_{HPMSVtype}$	=	annual VMT by HPMS vehicle type; and
$TF_{SUT,Age}$	=	travel fraction by SUT and age.

The annual VMT by road type, SUT, and age was then allocated to each month, day period (weekday and weekend day), and hour by multiplying by the month VMT fraction, the day VMT fraction, and hour VMT fraction, and dividing by the number of weeks in the month (number of days in the month divided by seven). Following is the formula for calculating the VMT by month, day period, hour, road type, SUT, and age:

$$VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age} = AVMT_{RoadType,SUT,Age} * monthFract_{Month} * dayFract_{Month,DayType} * hourFract_{DayType,Hour} / (noOfDays_{Month} / 7)$$

Where:

$VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age}$	=	VMT by month, day period, hour, road type, SUT, and age,
$AVMT_{RoadType,SUT,Age}$	=	annual VMT by road type, SUT, and age;
$monthFract_{Month}$	=	month VMT fraction by month;
$dayFract_{Month,DayType}$	=	day VMT fraction by month and day type; and
noOfDays	=	number of days in the month.

The average speed by day type, hour, SUT, and road type was then calculated by multiplying the average speed distribution (day type, hour, SUT, road type, and average speed bin) by the average speed bin speeds and summing across the speed bins. Following is the formula used to calculate the average speed by day type, hour, SUT, and road type:

$$ASPD_{DayType,Hour,SUT,RoadType} = \sum(SPDD_{DayType,Hour,SUT,RoadType,SpeedBin} * SPDB_{SpeedBin})$$

Where:

$ASPD_{DayType,Hour,SUT,RoadType}$	=	average speed by day type, hour, SUT, and road type;
$SPDD_{DayType,Hour,SUT,RoadType,SpeedBin}$	=	average speed distribution by day type, hour, SUT, road type, and average speed bin;
$SPDB_{SpeedBin}$	=	speed bin speeds by speed bin; and
$\sum()$	=	sum across speed bins.

The SHO by month, day period, hour, road type, SUT, and age was then calculated by dividing the VMT (month, day period, hour, road type, SUT, and age) by the average speed (day type, hour, SUT, and road type). Following is the formula used for calculating the SHO by month, day period, hour, road type, SUT, and age:

$$SHO_{Month,DayPeriod,Hour,Roadtype,SUT,Age} = VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age} / ASPD_{DayType,Hour,SUT,RoadType}$$

Where:

$SHO_{Month,DayPeriod,Hour,Roadtype,SUT,Age}$	=	SHO by month, day period, hour, road type, SUT, and age;
$VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age}$	=	VMT by month, day period, hour, road type, SUT, and age; and
$ASPD_{DayType,Hour,SUT,RoadType}$	=	average speed by day type, hour, SUT, and road type.

The SHO by month, day period, hour, road type, SUT, and age was then summed across the road types to produce the SHO by month, day period, hour, SUT, and age. This SHO was then used to calculate the SHP by month, day period, hour, SUT, and age. The vehicle population (SUT and age) was multiplied by the number of days in the day period (5 for weekday period and 2 for weekend day period) to calculate the day period vehicle population. The SHO (month, day period, SUT, and age) was then subtracted from the day period vehicle population to calculate the SHP by month, day period, hour, SUT, and age. Following is the formula used to calculate the SHP by month, day period, hour, SUT, and age:

$$SHP_{Month,DayPeriod,Hour,SUT,Age} = (VehPop_{SUT,Age} * noOfRealDays) - SHO_{Month,DayPeriod,Hour,SUT,Age}$$

Where:

$SHP_{Month,DayPeriod,Hour,SUT,Age}$	=	SHP by month, day period, hour, SUT, and age;
$VehPop_{SUT,Age}$	=	vehicle population by SUT and age;
noOfRealDays	=	number of days in the day period (5 for weekday, 2 for weekend day); and
$SHO_{Month,DayPeriod,Hour,SUT,Age}$	=	SHO by month, day period, hour, SUT, and age.

The SHP by SUT for the month and day type to be annualized (July weekday in this case) was then calculated using the SHP by month, day period, hour, SUT, and age. For those SHP values greater than zero (negative SHP values are set to zero since those values indicate that SHP does not exist), the SHP (month, day period, hour, SUT, and age) was divided by the number of days in the day period (5 for weekday in this case) and summed across hour and age. Following is the formula for calculating the daily SHP by SUT:

$$DSHP_{SUT} = \sum MAX[\ SHP_{Month,DayPeriod,Hour,SUT,Age}\ /\ noOfRealDays,\ 0]$$

Where:

$DSHP_{SUT}$	=	daily SHP by SUT for the month and day type annualized (July weekday in this case);
$SHP_{Month,DayPeriod,Hour,SUT,Age}$	=	SHP by month, day period, hour, SUT, and age for the month and day type annualized (July weekday in this case);
noOfRealDays	=	number of days in the day period annualized (5 for weekday in this case); and
$\sum$MAX[ ]	=	sum of the maximum value between ($SHP_{Month,DayPeriod,Hour,SUT,Age}$ / noOfRealDays) and 0 across hour and age.

The annual SHP by SUT was calculated using a similar procedure as the daily SHP except that the calculations were performed for each month and day period. Following is the formula for calculating the annual SHP by SUT:

$$ASHP_{SUT} = \sum MAX[\ SHP_{Month,DayPeriod,Hour,SUT,Age}\ /\ noOfRealDays,\ 0]$$

Where:

$ASHP_{SUT}$	=	annual SHP by SUT;
$SHP_{Month,DayPeriod,Hour,SUT,Age}$	=	SHP by month, day period, hour, and SUT;
noOfRealDays	=	number of days in the day period (5 for weekday, 2 for weekend day); and
$\sum$ MAX[ ]	=	sum of the maximum value between ($SHP_{Month,DayPeriod,Hour,SUT,Age}$ / noOfRealDays) and 0 across month, day period, hour, and age.

The annual SHP by SUT were then divided by the daily (July weekday) SHP by SUT to produce the SHP annualization factors by SUT. Table 32 and Table 33 show the SHP annualization factors by SUT.

Table 32. Annual SHP, Summer Weekday SHP and Annualization Factors.

sourceTypeID	Bexar County			Comal County			Guadalupe County		
	Annual	Daily	Factor	Annual	Daily	Factor	Annual	Daily	Factor
11	215,069,002.8	589,200.0	365.0	215,069,002.8	589,200.0	365.0	215,069,002.8	589,200.0	365.0
21	7,573,296,691.4	20,718,660.9	365.5	7,573,296,691.4	20,718,660.9	365.5	7,573,296,691.4	20,718,660.9	365.5
31	2,043,116,879.3	5,591,010.5	365.4	2,043,116,879.3	5,591,010.5	365.4	2,043,116,879.3	5,591,010.5	365.4
32	520,435,464.7	1,424,177.1	365.4	520,435,464.7	1,424,177.1	365.4	520,435,464.7	1,424,177.1	365.4
41	1,238,679.7	3,376.2	366.9	1,238,679.7	3,376.2	366.9	1,238,679.7	3,376.2	366.9
42	2,520,671.5	6,871.2	366.8	2,520,671.5	6,871.2	366.8	2,520,671.5	6,871.2	366.8
43	6,998,932.9	19,078.7	366.8	6,998,932.9	19,078.7	366.8	6,998,932.9	19,078.7	366.8
51	6,457,464.1	17,637.1	366.1	6,457,464.1	17,637.1	366.1	6,457,464.1	17,637.1	366.1
52	129,148,816.1	352,741.1	366.1	129,148,816.1	352,741.1	366.1	129,148,816.1	352,741.1	366.1
53	13,228,359.4	36,130.1	366.1	13,228,359.4	36,130.1	366.1	13,228,359.4	36,130.1	366.1
54	5,120,893.6	13,986.8	366.1	5,120,893.6	13,986.8	366.1	5,120,893.6	13,986.8	366.1
61	47,317,791.6	129,041.2	366.7	47,317,791.6	129,041.2	366.7	47,317,791.6	129,041.2	366.7
62	55,107,254.6	150,284.1	366.7	55,107,254.6	150,284.1	366.7	55,107,254.6	150,284.1	366.7

Table 33. Annual SHP, Summer Weekday SHP and Annualization Factors.

sourceTypeID	Kendall County			Wilson County		
	Annual	Daily	Annual	Daily	Annual	Daily
11	10,060,310.9	27,562.0	10,060,310.9	27,562.0	10,060,310.9	27,562.0
21	214,754,406.3	587,896.4	214,754,406.3	587,896.4	214,754,406.3	587,896.4
31	79,295,723.6	217,101.2	79,295,723.6	217,101.2	79,295,723.6	217,101.2
32	20,198,677.5	55,301.3	20,198,677.5	55,301.3	20,198,677.5	55,301.3
41	121,160.5	331.7	121,160.5	331.7	121,160.5	331.7
42	246,101.3	673.7	246,101.3	673.7	246,101.3	673.7
43	683,218.0	1,870.2	683,218.0	1,870.2	683,218.0	1,870.2
51	601,145.3	1,645.4	601,145.3	1,645.4	601,145.3	1,645.4
52	12,023,222.5	32,909.3	12,023,222.5	32,909.3	12,023,222.5	32,909.3
53	1,231,623.0	3,371.1	1,231,623.0	3,371.1	1,231,623.0	3,371.1
54	476,609.7	1,304.6	476,609.7	1,304.6	476,609.7	1,304.6
61	1,058,524.7	2,871.6	1,058,524.7	2,871.6	1,058,524.7	2,871.6
62	1,232,787.8	3,344.4	1,232,787.8	3,344.4	1,232,787.8	3,344.4

Emissions Rate Annualization Factors

Emissions rate annualization factors by pollutant, process, SUT, fuel type, and aggregate road type (restricted access, unrestricted access, off-network) were also used to create annual emissions from the summer weekday emissions. These factors were based on two MOVES inventory mode runs: one to produce annual activity and emissions (e.g., summer and winter seasonal inputs); and one to produce summer weekday emissions and activity (using similar inputs to the summer weekday MOVES emissions rate runs used to develop the summer weekday emissions inventories). Annual emissions rates, summer weekday emissions rates and annualization factors (annual rate divided by summer weekday rate) by pollutant, process, SUT, fuel type, and aggregate road type were calculated using the output from these two MOVES runs.

MOVES Inventory Mode Runs

For the development of the emissions rate annualization factors, two inventory mode runs were performed, one for a summer weekday, and one with a season variation for annual.

In the section entitled "Estimation of Summer Weekday Emission Factors" Table 20 and Table 21 summarize the RunSpec settings and CDB inputs, respectively, for the summer weekday emissions rate mode runs for the rates development. The inventory mode runs for rate annualization factor development are very similar to the rates mode runs; their differences in RunSpecs and CDBs are highlighted here.

RunSpecs: For the inventory mode runs, particular Scale, Time Spans, Geographic Bounds, and Output Emissions Detail settings are different. For inventory mode, "Calculation Type" is set to "Inventory" in the Scale panel; "Region" in the Geographic Bounds panel is changed from "Zone and Link" to "County;" and the appropriate CDB name is set. In the Time Spans panel, for summer weekday, there is no difference between inventory mode and rates mode, but for the generalized annual inventory mode run, for "Days," both "Weekdays" and "Weekend" are selected, and for "Months," both "January" and "July" are selected. Under Output Emissions Detail for inventory mode, "Time" is set to "24 Hour Day" for the summer weekday run, and to "Month" for the generalized annual run.

CDBs: For the inventory mode, two CDBs were used, one for the summer weekday run and one for the generalized annual run. For the summer weekday run, the same CDB was used as was used for the rates mode (average June through August) summer weekday run. (The summer weekday runs did not include any of the local winter season data that were developed for use in the generalized annual inventory mode runs.) For the generalized annual inventory mode run, the inputs were consistent with the summer weekday run, except that average (December, January, February) winter meteorology (see Appendix I) and winter fuels inputs (see Table 24 and Table 25) were included. Additionally, month VMT fractions were changed to account for local semi-annual seasonal activity at the associated district level (July and January monthVMTfraction values, respectively, were set to one-sixth of the generalized, semi-annual summer [April through September] and one-sixth of the winter [remaining six months] ATR counts).

TTI built the MRSs and CDBs for each county and checked that they were prepared as intended. The MOVES runs were performed, checked for errors and applied in the calculation of the emissions rate annualization factors for each county. The MRSs, CDBs (and scripts used to build them), and MOVES output were provided as a part of the electronic data submittal (see Appendix A).

Emissions Rate Annualization Factor Calculations

The first component of the emissions rate annualization factors is the annual emissions rates. The emissions output from the annual MOVES inventory mode run was aggregated by pollutant, process, SUT, fuel type, and aggregate road type (restricted access, unrestricted access, off-network). The activity output was also aggregated by SUT, fuel type, aggregate road type, and activity type (i.e., VMT, starts, SHI, APU hours, and SHP). The annual emissions rates were then calculated by dividing the aggregated emissions output by the appropriate aggregated activity to produce annual emissions rates by pollutant, process, SUT, fuel type, and aggregate road type. Using the same procedure, summer weekday emissions rates were calculated using the output from the summer weekday MOVES inventory mode run.

The emissions rate annualization factors were then calculated by dividing the annual emissions rates (including any necessary units conversion factors) by the summer weekday emissions rates. In those cases where annual emissions rates exist but summer weekday rates do not, the emissions rate annualization factor was set to zero, which will cause the annual emissions rate to be used in the annual emissions calculation procedure.

Annual Activity and Emissions Calculations

The summer weekday inventory output consists of two formats: the main tab-delimited format (activity and emissions by pollutant, process, SUT/fuel type, and road type) and the SCC tab-delimited format (activity and emissions by pollutant and SCC). Although these files contain the same activity and emissions results, the format is quite different. Therefore, both formats were converted to annual emissions separately using the same procedures (i.e., two annual activity and emissions output formats were produced).

For the main tab-delimited format, the annual activity was calculated by multiplying the 24-hour activity from the summer weekday tab-delimited activity and emissions file by the appropriate activity factor. Annual activity was calculated for VMT, SHI, APU hours, starts, and SHP.

The annual emissions were also calculated using the 24-hour emissions from the summer weekday tab-delimited activity and emissions file. For each pollutant, the annual emissions were calculated for each process by multiplying the summer weekday emissions by the appropriate activity factor and emissions rate annualization factor. In the case where the emissions rate annualization factor is zero and the annual emissions rate is greater than zero, the annual emissions were calculated by multiplying the appropriate annual activity by the annual emissions rate. The composite pollutant emissions were also calculated by summing the emissions for each process associated with the pollutant.

For the SCC tab-delimited format, the summer weekday SCC tab-delimited activity and emissions were converted to annual activity and emissions using the same procedures as the main tab-delimited format. Thus creating an equivalent of the annual main tab-delimited format with the activity and emissions aggregated by SCC.

Conversion of Annual Emissions Inventories to XML Format

TTI converted the annual emissions and activity results for each county to a format compatible for uploading to the TCEQ's TexAER based on the EPA's EIS NEI CERS XML format, which uses EPA's EIS inventory data codes, using the same procedures as the conversion of the weekday 24-hour emissions and activity. Each run produced a LST file (execution information, input/output file listings, input summaries, and input and output totals summaries with calculated differences for QA checks), the XML file, and one XML output summary of SCC-labeled inventory data in a tab-delimited text file form for each county included in the run. All these files were included in the electronic data submittal (Appendix A).

ADDITIONAL CDBS FOR MOVES INVENTORY MODE

TTI developed two extra sets of CDBs for each county consistent with the emissions inventory data that may be used with MOVES in the inventory mode: one set of summer weekday CDBs and one set of annual CDBs. These inventory mode CDBs were designed to input the appropriate (daily) activity data (daily for the summer weekday CDBs and annual for the annual CDBs), and with the appropriate MRSs, produce summer weekday output inventory estimates consistent with, but not necessarily identical to, the summer weekday and annual inventories.

The summer weekday inventory CDBs include the 26 input data tables shown in Table 34 with corresponding data sources. The inventory CDBs include the same 20 MOVES tables used in the link-based inventory analysis rates mode CDBs (see Table 21), plus six additional tables (hotellingactivitydistribution, hotellinghours, sourcetypeage, starts, monthofanyyear, and dayofanyweek).

The summer weekday inventory mode CDB data source categories are:

- Rates CDB (mainly local data directly from the link-based inventory analysis rates CDBs);
- MOVESactivityInputBuild utility output (for activity inputs built from the applicable link-based inventory data);
- OffNetActCalc utility output with adjustments (for hotellinghours, starts);
- VehiclePopulationBuild utility output (for vehicle population estimates);
- MOVES defaults (only for hotellingactivitydistribution); and
- Adjusted MOVES defaults (for activity allocation factors modified as needed to produce daily output from daily activity input, and for sourcetypeage table relativeMAR adjustments to produce VMT proportions between HPMS vehicle categories that more closely reflect the local VMT Mix).

The inventory development utilities descriptions, to include MOVESacivityInputBuild, OffNetActCalc, and VehiclePopulationBuild utilities are included in Appendix B.

Table 34. Summer Weekday MOVES Inventory Mode CDB Data Sources.

Table	Data Source
avft	Rates CDB
avgspeeddistribution	MOVESactivityInputBuild utility output
county	Rates CDB
countyyear	Rates CDB
dayvmtfraction	MOVES default with dayVMTFraction = 1 (dayID = 5) and dayVMTFraction = 0 (dayID = 2)
fuelsupply	Rates CDB
fuelformulation	Rates CDB
hotellingactivitydistribution	MOVES defaults
hotellinghours	OffNetActCalc utility output with travel fractions (developed using the age distribution and relative MAR) applied to distribute to ageID
hourvmtfraction	MOVESactivityInputBuild utility output
hpmsvtypeyear	MOVESactivityInputBuild utility output
imcoverage	Rates CDB
monthvmtfraction	Rates CDB with monthVMTFraction = 1
roadtype	MOVESactivityInputBuild utility output
roadtypedistribution	MOVESactivityInputBuild utility output
sourcetypeage	MOVES default with relativeMAR adjusted for VMT Mix (travel fractions calculated using relativeMAR adjusted to match 24-hour VMT from link-level inventory)
sourcetypeagedistribution	Rates CDB
sourcetypeyear	VehiclePopulationBuild utility output
starts	OffNetActCalc utility output with age distribution applied to distribute to ageID
state	Rates CDB
year	Rates CDB
zone	Rates CDB
zonemonthhour	Rates CDB
zoneroadtype	Rates CDB
monthofanyyear	MOVES default with noOfDay = 7
dayofanyweek	MOVES default with noOfRealDays = 1

The annual inventory CDBs contain the same input data tables as the summer weekday inventory CDBs, excluding the monthofanyyear and dayofanyweek data tables (not required for annual inventory mode CDBs). However, these annual inventory CDBs do have different data requirements (i.e., annual activity instead of summer weekday activity) and sources (see Table 35). The annual inventory mode CDB data source categories are:

- Annual inventory Mode CDB from the emissions rate annualization procedure (mainly local data directly from the link-based inventory analysis rates CDBs);
- Local data (2004-2013 ATR data by TxDOT district to build day VMT fractions, hour VMT fractions, and month VMT fractions);
- MOVESactivityInputBuild utility output (for activity inputs built from the applicable link-based inventory data);
- VehiclePopulationBuild utility output (for vehicle population estimates);
- MOVES defaults;
- Annual activity from the activity annualization procedures; and
- Adjusted MOVES defaults (for activity allocation factors modified as needed to produce daily output from daily activity input, and for sourcetypeage table relativeMAR adjustments to produce VMT proportions between HPMS vehicle categories that more closely reflect the local VMT Mix).

Table 35. Annual MOVES Inventory Mode CDB Data Sources.

Table	Data Source
avft	Annual inventory mode CDB[1]
avgspeeddistribution	MOVESactivityInputBuild utility output for both dayID 5 and dayID 2
county	Annual inventory mode CDB[1]
countyyear	Annual inventory mode CDB[1]
dayvmtfraction	Local Data (see Appendix K)
fuelsupply	Annual inventory mode CDB[1] with monthID 1 data for months 1-3, 10-12; monthID 7 data for months 4-9
fuelformulation	Annual inventory mode CDB[1]
hotellingactivitydistribution	MOVES defaults
hotellinghours	Annual activity[2]
hourvmtfraction	Local Data (see Appendix K)
hpmsvtypeyear	Annual activity[2]
imcoverage	Annual inventory mode CDB[1]
monthvmtfraction	Local Data (see Appendix K)
roadtype	MOVESactivityInputBuild utility output
roadtypedistribution	MOVESactivityInputBuild utility output
sourcetypeage	MOVES default with relativeMAR adjusted for VMT Mix (travel fractions calculated using relativeMAR adjusted to match 24-hour VMT from link-level inventory)
sourcetypeagedistribution	Annual inventory mode CDB[1]
sourcetypeyear	VehiclePopulationBuild utility output
starts	Annual activity[2]
state	Annual inventory mode CDB[1]
year	Annual inventory mode CDB[1]
zone	Annual inventory mode CDB[1]
zonemonthhour	Annual inventory mode CDB[1] with monthID 1 data for months 1-3, 10-12; monthID 7 data for months 4-9
zoneroadtype	Annual inventory mode CDB[1]

[1] From emissions rate annualization procedure.
[2] From the activity annualization procedures.

TTI built the MOVES inventory mode CDBs, checked that each one contained all the required tables, and that they were populated as intended. These MOVES inventory mode CDBs along with the MySQL scripts used to create them, were provided as a part of the electronic data submittal (see Appendix A).

QUALITY ASSURANCE

Analyses and results were subjected to appropriate internal review and QA/QC procedures, including independent verification and reasonableness checks. All work was completed consistent with applicable elements of ANSI/ASQ E4-2004: *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Technology Programs* and the TCEQ Quality Management Plan.

Quality Assurance Project Plan (QAPP) Category II (Modeling for NAAQS Compliance) is the QAPP category that most closely matches these objectives and establishes QAPP requirements for projects involving applied research or technology evaluations. Internal review and quality control measures consistent with applicable NRML QAPP requirements, along with appropriate audits or assessments of data and reporting of findings, were conducted. These included, but were not limited to, the elements outlined in the following description.

A. Project Management

The project management was as listed previously in the Acknowledgements section.

The definition and background of the problem addressed by this project, the project/task description, and project documents and records produced are as described previously in the Purpose and Background sections. No special training or certifications were required. The TTI project manager assured that the appropriate project personnel had and used the most current, approved version of the QAPP.

After receiving the Notice to Commence (NTC) from TCEQ, the TTI project manager provided a detailed pre-analysis plan to the TCEQ project manager for review and concurrence. Upon concurrence of the pre-analysis plan, the TTI project manager distributed the pre-analysis plan to the TTI inventory developers for use in both the inventory development and QA review process. TTI maintains records of the project QA checks as a part of the project archive, for at least five years.

The objective was to produce the emissions inventory product in the quality suited to its purpose as specified (i.e., inventories needed for HGB re-designation analyses purposes), informed by, and consistent with, the appropriate guidance and methods provided in the listed references, as detailed in the pre-analysis plan, and in consultation with the TCEQ project manager.

Basic criteria were used to assure that the acceptable quality of the product was met – product developers verified that the process and product were as specified, to include:

- The product met the purpose of the emissions analysis (i.e., for use in the HGB eight-county area re-designation analysis);

- The full extent of the modeling domain (i.e., analysis years, geographic coverage, seasonal periods, days, sources, pollutants) was included;
- Agreed methods, models, tools, and data were used (i.e., as listed in the detailed pre-analysis plan);
- The required output data sets were produced in the appropriate formats in accordance with the pre-analysis plan;
- Any deficiencies found during development and end-product quality checks (as discussed in QAPP Section D) were corrected; and
- Aggregate emissions estimate results were assessed for comparability with available, similarly produced emissions estimates.

B. Data Generation and Acquisition

Note that no sampling of data was involved in the emissions inventory development, thus only existing data (non-direct measurements) were used for this project.

The data needed for project implementation were in the categories needed for development of emissions rate model inputs and adjustment factors, and for development of the activity inputs for external emissions calculations. These emissions factor model inputs and activity inputs were developed using data sources as outlined previously and/or methods and procedures as detailed in the references listed, and as provided in the pre-analysis plan.

All data used either as direct input or to produce inputs (e.g., to the MOVES model or to TTI's emissions inventory development utilities used, which were listed in the pre-analysis plan) were reviewed by TTI for suitability before use. The data sets for the project were provided by TxDOT, a Metropolitan Planning Organization (MPO) or Council of Governments (COG), TCEQ, and/or the EPA, and in most cases were QA'd by the providing agency. The data needed may include: HPMS data (from TxDOT's Roadway Inventory Functional Classification Record [RIFCREC] report); regional travel demand model data; speed model data; vehicle registration data; ATR data; vehicle classification count data; meteorological data; fuels data; MOVES emissions model data; extended idling activity data; and vehicle I/M program design data.

Any significant problems found during data review, verification, and/or validation (see QA criteria and methods discussion in section D) were to be corrected, and the QA procedure was repeated until satisfied. No significant problems were found.

Data Management: TTI emissions inventory data developers work as a closely coordinated team. The assigned staff used the same electronic project folder structure on their individual workstations. As various scripts, inputs, and outputs were developed in the emissions inventory development process, data were shared within the team for crosschecking via an intra-net, flash drive, or external hard drive. To perform the MOVES model runs, a computer cluster (multiple computer) configuration or individual workstation configuration was used. After input data were QA'd, depending on the size of the data set, the data sets were backed up and stored in compressed files. These activities were performed throughout the process until the final products were produced.

For MOVES model runs to produce emissions factor look-up tables for the emissions inventories, all run files (MOVES model inputs and batch files) were produced on an individual workstation. After the MOVES input data and batch files (i.e., Run Files) were QA'd, they were either executed on an individual workstation, or they were copied (via external hard drive) to the cluster's master computer and executed. Upon execution, completion, and error checking, the MOVES output databases and run log text files were (for cluster runs first copied to an individual workstation), archived and processed further in preparation for input to the emissions calculations.

After the final product was completed, all the project data archives were compiled on a set of optical data discs (CD-ROM or DVD, depending on size), or on an external drive for very large project data sets. A complete archive of the project data is kept by TTI (the computer models and emissions inventory development utilities used in the process are included). An electronic data submittal package (containing the project deliverables as listed in Appendix A) was produced along with data descriptions (on CD-ROM, DVDs, or external hard drive, depending on needed storage space) and delivered to TCEQ.

C. Assessment and Oversight

The following assessments were performed.

- Verified that the overall scope was met (consistent with the intended purpose, for specified temporal resolution and geographic coverage, for specified sources, pollutants, and emissions processes).
- Checked input data preparation, and model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files) were prepared according to the plan; and
- Checked that correct output data were produced (includes interim output [output that becomes input to a subsequent step in the inventory development process], as well as the final product). Records were kept of the checks performed.

In the case that any inconsistencies or deficiencies were found, the issue was directly communicated to the responsible staff for corrections (or the outside agency staff involved, if provided from outside of TTI, if needed). After a correction was made, the QA checks were performed again to ensure that the additional work resulted in the intended quality assured result, and the correction was noted in the QA record (process was performed until QA check was satisfied).

In addition, technical systems audits were performed as appropriate. Audits of data quality at the requisite 25% level were performed for any data collected or produced as part of this study. QA findings were reported in this draft report and will also be in the final reports.

D. Data Validation and Usability

Erroneous or improper inputs at any point during the emissions inventory development process may produce resulting emissions estimates that are inaccurate and may not be suitable for their intended purpose. Adherence to the inventory process flow with performance of the integrated

QA checks at each step of the process was of the utmost importance to ensure that the results met the project objectives.

Therefore, the QA checks listed were performed until satisfied to ensure that the resulting emissions inventories met the TCEQ's requirements of intended use.

TTI verified that the overall scope of the emissions analysis has been met as prescribed in the pre-analysis plan, to include:

- Purpose of the emissions analysis (i.e., needed for the HGB re-designation analysis);
- Extent of the modeling domain (e.g., analysis years, geographic coverage, seasonal periods, days, sources, pollutants);
- Methods, models, and data used (e.g., default versus local input data sources); and
- Procedures and tools used and all required emissions output data sets were produced.

TTI performed checks on input data preparation, model or utility execution instructions (e.g., run specifications, scripts, JCFs, command files), and output, as appropriate to the component:

- Input data preparation checks:
    - Verified the basis of input data sets against the pre-analysis plan: Actual historical or latest available data, validated model, expected values or regulated limits, regulatory program design, model defaults, surrogates, professional judgment; aggregation levels;
    - Data development: Depending on the procedure and particular input data set, calculations were verified (e.g., re-calculated independently and compared with originally prepared values – if spot-checking a series of results, included extremes and intermediate values);
    - Completeness: Verified that input data sets were within the required dimensions, and all required fields were populated and properly coded or labeled;
    - Format: Verified that formats were within required specifications (e.g., field positions, data types and formats, and file formats), if any;
    - Reasonability checks: (discussed in the next section); and
    - Ensured that any inputs provided from external sources were quality assured, as listed previously.
- Checked the model or utility execution instructions:
    - Verified that the correct number of utility or model run specifications were prepared for each application (e.g., by year, county, season, day type); and
    - Verified that each utility or model run script included the correct modeling specifications (e.g., commands, input values, input and output file paths, output options) for the application per applicable user guide.
- Checked for the successful completion of model and utility executions:

- Verified that the correct number of each type of output file was produced by the particular model or utility;
- Checked for any unusual output file sizes;
- Searched output (e.g., utility listing files or model execution logs that contain error and warning records) for warnings/errors; and
- Checked the summary information provided in output listing files for any unusual results.

TTI performed further checks for consistency, completeness, and reasonability of data output from model or utility applications:

- Verified that the data distributions and allocation factors produced or used sum to 1.0, as appropriate (e.g., hourly travel factors within a time period, proportion of travel by vehicle categories on a particular roadway category);
- Verified that the required data fields were present, populated, and properly coded or labeled; verified that data and file formats were within specifications;
- Verified that any activity, emissions rate, or emissions adjustments were performed as intended (e.g., seasonal activity factor, emissions control program adjustment);
- For data sets prepared with temporal or geographic variation (e.g., activity distributions between weekends/weekdays, vehicle mix by day type, or average speeds between road types or time periods), compared and noted whether directional differences were as expected;
- Checked for consistency between data sets (e.g., compared detailed spatially and temporally disaggregated activity estimates [e.g., link VMT] to original aggregate totals, activity total summaries between utility applications [e.g., link-VMT producer and emissions calculator], and input hourly distributions versus hourly summaries from the link activity output data);
- Calculated county, 24-hour, aggregate emissions rates (from aggregate VMT and emissions output) and compared the rates between counties examining the results for outliers while assessing the reasonability of any relative and directional differences (e.g., qualify based on activity distributions by road type and speed, mix of vehicles by road type, meteorological variation, control program coverage). Compared the results to results from previous emissions analyses where available; and
- Calculated county, 24-hour aggregate rates by vehicle class and compared between vehicle classes. Examined the results for consistent patterns.

Any additional data products required for the emissions analysis were subjected to the appropriate QA checks previously listed.

REFERENCES

- 2008 NEI/EIS Implementation Plan, Section 2, Transitioning from National Emission Inventory Format to the 2008 NEI, available at http://www.epa.gov/ttn/chief/net/neip/.
- 2008 NEI/EIS Implementation Plan, Appendix 2, Consolidated Emissions Reporting Schema (CERS) and Examples, available at http://www.epa.gov/ttn/chief/net/neip/.
- 2008 NEI/EIS Implementation Plan, Appendix 6, Reporting Code Tables, available at http://www.epa.gov/ttn/chief/net/neip/.
- EPA (1992). Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. EPA420-R-92-009, Emission Planning and Strategies Division. Office of Mobile Sources and Technical Support Division, Office of Air Quality Planning and Standards. December 1992.
- EPA (2001). Memorandum: Texas Low Emission Diesel (LED) Fuel Benefits. To Karl Edlund, EPA, Region VI, from Robert Larson, EPA. Office of Transportation and Air Quality (OTAQ), National Vehicle and Fuel Emissions Laboratory, Ann Arbor, MI. September 27, 2001.
- EPA (2002). Guidance for Quality Assurance Project Plans for Modeling. EPA QA/G-5M, EPA/240/R-02/007. Office of Environmental Information. December 2002.
- EPA (2005). *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter NAAQS and Regional Haze Regulations*. EPA-454/R-05-001, issued by the Emissions Inventory Group, Emissions, Monitoring and Analysis Division. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. August 2005.
- EPA (2014). *Motor Vehicle Emission Simulator (MOVES), User Guide for MOVES2014*. EPA420-B-14-055, Assessment and Standards Division. Office of Transportation and Air Quality. July 2014.
- Eastern Research Group, Inc. (2014). *2014 Summer Fuel Field Study, Final Report*. ERG No. 0292.03.020. August 15, 2014.
- Texas Transportation Institute (2014). *TTI Emissions Inventory Estimation Utilities Using MOVES: MOVES2014UTL User's Guide*. December 2014.

APPENDIX A:
ELECTRONIC DATA SUBMITTAL DESCRIPTION

Statewide (Excluding the 12 Counties in the Dallas/Fort Worth Area) On-road Mobile 2014 AERR and Toxics Inventory – Electronic Data Submittal Description

This appendix describes the MOVES2014-based emissions inventory data files for seven areas (242 counties) that TTI submitted to TCEQ, per Proposal for Grant Activities No. 582-15-52083-17. The inventory data files include:

- Seasonal weekday and annual emissions inventory data summaries:
  - Inventory calculator tab-delimited text file outputs, a set by MOVES SUT, and a set by SCC (as provided in the MOVES "scc" table); and
  - XML formatter outputs: XML files (for upload to EPA's EIS and TCEQ's TexAER), and Tab-delimited summaries by SCC (from the XML results);
- MOVES run inputs: CDBs and Runspec files used in the MOVES runs, and MySQL scripts for building the CDBs; and
- Additional CDBs developed for uploading to EPA's EIS.

The 242 Texas counties are grouped by area and activity basis (TDM-based or HPMS-based). The first six areas are region-based; the remaining 214 counties are statewide-based. The regional method uses TDM activity data if available and finer detail in some MOVES inputs.

AERR Inventories – 242 Counties by Area and Activity Basis

Area (Area Label)	TDM Counties (TDM Label)	HPMS Counties (VMT Label)
1. Houston-Galveston-Brazoria Area (HGB)	Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller (HTDM)	–
2. Beaumont-Port Arthur Area (BPA)	Hardin, Jefferson, Orange (BTDM)	–
3. El Paso County (ELP)	El Paso (ETDM)	–
4. Austin Area (AUS) [1]	Bastrop, Burnet[1], Caldwell, Hays, Travis, Williamson (ATDM)	–
5. San Antonio Area (SAN)	Bexar, Comal, Guadalupe, Kendall, Wilson (STDM)	–
6. Northeast Texas near-nonattainment area (TLM)	Gregg (LTDM), Smith (TTDM)	Harrison, Rusk, Upshur (HPMS)
7. Remainder of Texas (statewide Vlink) [2]	–	214 counties[2] (HPMS)

[1] Burnet County was recently added to the Austin area TDM.

[2] All remaining Texas counties except for the DFW MSA (Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise). See the list at the end of this appendix.

EMISSIONS INVENTORY DATA SUMMARIES

As summarized in the following table, there were 243 seasonal weekday emissions runs and 242 annual emissions estimation runs. The county level emissions inventory data files (inventory calculation utility output) were provided in zip files by area, plus an additional zip file was provided containing inventory data summary spreadsheets.

Emissions Inventory Types Summary

Area	Counties	County Inventories (Utility)[1]	
		Seasonal Weekday (EmsCalc)	Annual (EmsCalcAnn)
El Paso	1	1 summer 1 winter	1
Other Regions	27	27 summer	27
Remainder of State (except DFW MSA 12)	214	214 summer	214
Total	**242**	**243**	**242**

[1] The summer weekday inventory output was and input along with other factors to the annual emissions calculations.

Summary Spreadsheets
The inventory extracts and summary spreadsheets were included in:
AERR_Toxics_summaries_xls.zip.

EmsCalc and EmsCalcAnn
The EmsCalc and EmsCalcAnn inventory output files were provided in sets of zip files by utility, each with seven zip files (one for each area):
AERR14_<area>_EmsCalcAnn Output.zip; and
AERR14_<area>_EmsCalc Output.zip.

The inventory output files for EmsCalcAnn are:
AERR14_<area>_<FIPS>_2014Ann_<VMTmodel>_ems.LST;
AERR14_<area>_<FIPS>_2014Ann_<VMTmodel>_ems.TAB; and
AERR14_<area>_<FIPS>_2014Ann_<VMTmodel>_sccoutput_ems.TAB.

The inventory output files for EmsCalc are (for El Paso there is also a "winwkd" set):
AERR14_<area>_<FIPS>_2014sumwkd_<VMTmodel>_ems.LST;
AERR14_<area>_<FIPS>_2014sumwkd_<VMTmodel>_ems.TAB; and
AERR14_<area>_<FIPS>_2014sumwkd_<VMTmodel>_sccoutput_ems.TAB.

As an example, the Bastrop County inventory files are:

EmsCalcAnn:
AERR14_AUS_48021_2014Ann_ATDM_ems.LST;
AERR14_AUS_48021_2014Ann_ATDM_ems.TAB; and
AERR14_AUS_48021_2014Ann_ATDM_sccoutput_ems.TAB.

EmsCalc:
AERR14_AUS_48021_2014sumwkd_ATDM_ems.LST;
AERR14_AUS_48021_2014sumwkd_ATDM_ems.TAB; and
AERR14_AUS_48021_2014sumwkd_ATDM_sccoutput_ems.TAB.

The LST files are utility execution listings of the run script, execution times, input and output file locations, as well various input and output data summaries. The two tab-delimited output file types are the standard inventory summary (by MOVES SUT and fuel type), and the SCC inventory summary (results by the SCCs listed in MOVES). The seasonal weekday standard output includes both hourly and 24-hour results (activity and emissions in units of pounds), and the seasonal weekday SCC output includes 24-hour results. For the annual runs, the standard and SCC output each contain annual period total results (aggregate activity and emissions in units of tons for the 2014 calendar year).

The activity estimates included in the TAB files are by SUT/fuel type and road type, or are off-network for non-roadway-based activity parameters:

- VMT;
- VHT (not included in annual);
- Speed (not included in annual);
- SHP (off-network);
- Extended Idle Hours (SHI) (off-network);
- APU Hours (off-network); and
- Starts (off-network).

The pollutants are tabulated by SUT/fuel type and by VMT model road type or as off-network depending on the emissions process and activity type (e.g., VMT or SHP for evaporative). In addition to the MOVES emissions processes, “composite” (pollutant totals) are included. The seasonal weekday and annual pollutant inventories include the same pollutants and processes. (HAPs were also included in the summer weekday runs, as summer weekday HAPs emissions were an input to the annual emissions calculations.)

XML Format

The XML formatter output files were produced for summer weekday, annual (and the winter weekday for El Paso). For summer weekday and annual, the 242 counties were divided into four parts, by FIPS code, the first 60, next 60, next 60, and last 62. Each run produced the three output file types (LST, XML, and TAB):

MOVESsccXMLformat_AERR14_mvs14_<period>_<Part#_##counties>.lst
MOVESsccXMLformat_AERR14_mvs14_<period>_<Part#_##counties>.xml
MOVESsccXMLformat_AERR14_mvs14_<period>_<Part#_##counties>_<FIPS1>_summary.tab
MOVESsccXMLformat_AERR14_mvs14_<period>_<Part#_##counties>_<FIPS2>_summary.tab
.
.
MOVESsccXMLformat_AERR14_mvs14_<period>_<Part#_##counties>_<FIPSn>_summary.tab

The LST provides a listing of the utility execution, the XML files contains the EIS CERS xml-formatted inventory data for all counties in the run (using 2014 NEI SCCs and pollutant codes for uploading to EPA's EIS and TCEQ's TexAER), and one output tab file per county in the run contains the county summary inventory data by SCC, from the XML output file. Nine runs were performed, four parts each for summer weekday and annual, and one run for the El Paso County winter weekday.

Note that the 2014 NEI SCCs sum the data by SUT and fuel type for each county (combines emissions from all processes, excluding refueling processes which were not applicable to this analysis). Additionally, MOVES output produces PAHs in gas and particle phases with separate pollutantIDs, as well as dioxins and furans in units of TEQ-mass. Thus, some aggregations of emissions were needed and performed to combine MOVES pollutantIDs into the appropriate EIS pollutant codes.

All the XML formatting output files and a summary file of MOVES pollutantID aggregations for EIS code compatibility were included in "AERR_Toxics_XML.zip."

MOVES SUMMER (AND WINTER FOR EL PASO) WEEKDAY EMISSIONS FACTOR DATA

Emissions factors were developed by county for the regional analyses (see the table of 28 regional counties at the end of this appendix); the statewide method was used to produce rates by county group (see the table of 214 Vlink counties also at the end of this appendix). The following emissions factor development files (used in conjunction with the MOVES default database, i.e., MOVESDB20141021) were provided:

- MOVES MRS input files;
- MOVES CDB inputs; and
- MySQL scripts for building CDBs.

MOVES Inputs
Regional county level runs – 29 MRS files and 29 CDBs (28 summer weekday +1 winter weekday).
Statewide county group level runs – 34 MRS files and 34 CDBs.

The files were provided in:
"aerr14_62swkd_1wwkd_er_mrss.zip", "aerr14_62s_1w_cdbs.zip;" and
"aerr14_62s_1w_cdbMySQLscripts.zip."

The MOVES Emissions Rate run MRS filenames and associated CDB names and scripts are:
MVS14_AERR14_<area or district><FIPS>_<period-day type>_ER.MRS;
MVS14_AERR14_<area or district><FIPS>_<period>_ER_CDB_in; and
MVS14_AERR14_<area or district><FIPS>_<period>_ER_CDB_in.SQL.

For example, the MOVES emissions rate run MRS files for the El Paso County winter weekday and for a select county group summer weekday are:
MVS14_AERR14_ELP48141_wwkd_ER.MRS; and
MVS14_AERR14_D0148033_swkd_ER.MRS.

The associated CDBs are:
MVS14_AERR14_ELP48141_w_er_cdb_in; and
MVS14_AERR14_D0148033_s_er_cdb_in.

"Area" is for the six regional analyses (e.g., AUS, BPA…., TLM) and district is the three-digit label used for TxDOT district (D01 Abilene, D02 Amarillo…., D25 Yoakum). "FIPs" is the actual county FIPS code for the county-level regional analyses, and is the FIPS code of the county representing the group of counties (e.g., the first county of the group, alphanumerically) for statewide analyses (see the tables at the end of this appendix for coding information).

ANNUAL EMISSIONS – RATES FACTORS

MOVES Inputs

Also provided were the MOVES runspecs and CDB inputs for production of inventory mode data used to compute emissions rate annualization factors input to the annual emissions calculations.

The files were provided in:

“aerr14_swkd_sw_ei_124mrss.zip” (a generalized annual and a summer weekday MRS for each of the 34 statewide county groups and 28 regional counties);
“aerr14_sw_ei_62cdbs.zip” (cdbs with seasonal data for generalized annual runs); and
“aerr14_sw_ei_62cdbscripts.zip” (scripts for building generalized annual cdbs).

The MOVES inventory mode run MRS filenames and associated CDB names and scripts are:

MVS14_AERR14_<area or district><FIPS>_<Ann-period>_EI.MRS;
MVS14_AERR14_<area or district><FIPS>_<swkd-period>_EI.MRS; and
MVS14_AERR14_<area or district><FIPS>_<Ann-period>_EI_CDB_in.SQL.

For example, the MOVES inventory run MRS files for the annual emissions rate factors development process for Bastrop County summer weekday are:

MVS14_AERR14_AUS48021_SW_EI.MRS; and
MVS14_AERR14_AUS48021_SWKD_EI.MRS.

The associated CDBs are:

mvs14_aerr14_AUS48021_sw_ei_cdb_in (for generalized annual run); and
mvs14_aerr14_AUS48021_s_er_CDB_in (for summer weekday run [from rates mode analysis]).

Note that there are twice as many the MOVES runs (MRS) as there were for the summer weekday link-based inventory analysis. To produce the annual emissions rate factors, an “Ann” run modeling summer and winter seasonality was made (with both weekend and weekday day types), and a summer weekday “Swkd” run was made. The inventory output results were post-processed into annual average daily and average summer weekday rates, and the annual emissions rate factors were calculated as the quotient “Ann”/”Swkd” emissions rates. No TxLED adjustments were made (because application in both numerator and denominator would essentially result in factor of unity).

Emissions Rate Annualization Factors

One annual rate factor utility run per 62 regional and statewide county/countygroup runs produced the emissions rate annualization factors used in the annual emissions calculations (i.e., in the conversion of summer weekday emissions to annual emissions). The output files, consisting of an LST and a TAB output file, are contained in: “aerr14_62ratesannfacts.zip”.

The utility output file were named, similarly to previous rate development files listed, such as:

mvs14_aerr14_AUS48021_RatesAnnFactCalc.lst; and
mvs14_aerr14_AUS48021_RatesAnnFactCalc.tab.

The MOVES inventory output produced from the MOVES inputs previously described were input to the annual rate factor calculation utility. Each run produced one LST and one TAB output file, the LST listing the run script, input/output files, run times, warnings, input/output summary information; and the TAB file containing the "annual" and seasonal weekday emissions and activity from the MOVES inventory output, and the calculated annual average daily and seasonal weekday emissions rates, and finally the resulting annual average day rate divided by the seasonal weekday rate, or annual emissions rate factor. The factors are by pollutant, process, SUT, fuel type, AnnFact road type (restricted access, unrestricted access, and offnetwork), and activity type.

Annual Activity Factors

The EmsCalcAnn utility LST output files, also provided as previously described, include summaries of the activity annual adjustments used in the annual emissions calculations. The factors were used to convert summer weekday inventory activity to annual activity and in combination with the annual emissions rate factors, to convert summer weekday inventory emissions to annual emissions.

ADDITIONAL CDBS

TTI developed and provided were two extra sets of CDBs for each of the 242 counties consistent with the emissions inventory data that may be used with MOVES in the inventory mode: one set of summer weekday CDBs and one set of annual CDBs. These inventory mode CDBs were designed to input the appropriate activity data (daily for the summer weekday CDBs and annual for the annual CDBs), and with the appropriate MRSs, produce summer weekday output inventory estimates consistent with, but not necessarily identical to, the summer weekday and annual inventories. The annual period CDBs may also be uploaded to EPA's EIS under the recent AERR revision.

The extra CDBs and scripts were delivered in one zip file for each of the seven areas, named such as:

AERR14_<AREA LABEL>_mvs14 Ann Inv Mode CDBs.zip (for the annual CDBs); and
AERR14_<AREA LABEL>_mvs14 Day Inv Mode CDBs.zip (for the seasonal weekday CDBs).

Regional Counties (28) Information – Emissions Factor Development

CountyID	CountyName	Area	DistrictName	Codescombination
48021	Bastrop	AUS	Austin	D04R2
48053	Burnet	AUS	Austin	D04R1
48055	Caldwell	AUS	Austin	D04R2
48209	Hays	AUS	Austin	D04R2
48453	Travis	AUS	Austin	D04R2ITW
48491	Williamson	AUS	Austin	D04R2ITW
48199	Hardin	BPA	Beaumont	D05R5
48245	Jefferson	BPA	Beaumont	D05R5
48361	Orange	BPA	Beaumont	D05R5
48141	El Paso	ELP	ElPaso	D11R3IEL
48039	Brazoria	HGB	Houston	D13R4IH5
48071	Chambers	HGB	Beaumont	D05R4
48157	Fort Bend	HGB	Houston	D13R4IH5
48167	Galveston	HGB	Houston	D13R4IH5
48201	Harris	HGB	Houston	D13R4IH5
48291	Liberty	HGB	Beaumont	D05R4
48339	Montgomery	HGB	Houston	D13R4IH5
48473	Waller	HGB	Houston	D13R4
48029	Bexar	SAN	SanAntonio	D21R2
48091	Comal	SAN	SanAntonio	D21R2
48187	Guadalupe	SAN	SanAntonio	D21R2
48259	Kendall	SAN	SanAntonio	D21R1
48493	Wilson	SAN	SanAntonio	D21R2
48183	Gregg	TLM	Tyler	D22R2
48203	Harrison	TLM	Atlanta	D03R2
48401	Rusk	TLM	Tyler	D22R2
48423	Smith	TLM	Tyler	D22R2
48459	Upshur	TLM	Atlanta	D03R2

[1] The 28 regional, county level modeling files are identified by the FIPS code of each county.

[2] The first three characters of the codescombination (fifth column) identify the TxDOT district (i.e., D1 through D25). The second two characters in the codescombination shows associated fuels regions (i.e., R1 through R6, consistent with the six MOVES fuel regions for Texas), and TxLED NOx adjustments were applied as appropriate (R1, R3, and R6 groups were not TxLED adjusted, and R2, R4, and R5 groups were adjusted for TxLED. I/M program counties are identified by the sixth through eighth characters (e.g., IEL, IH5).

Statewide 214 Counties: 34 County Groups[1,2] – Emissions Factor Analysis

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48033	Borden	Abilene	D01R1	Borden	48033
48033	Borden	Abilene	D01R1	Callahan	48059
48033	Borden	Abilene	D01R1	Fisher	48151
48033	Borden	Abilene	D01R1	Haskell	48207
48033	Borden	Abilene	D01R1	Howard	48227
48033	Borden	Abilene	D01R1	Jones	48253
48033	Borden	Abilene	D01R1	Kent	48263
48033	Borden	Abilene	D01R1	Mitchell	48335
48033	Borden	Abilene	D01R1	Nolan	48353
48033	Borden	Abilene	D01R1	Scurry	48415
48033	Borden	Abilene	D01R1	Shackelford	48417
48033	Borden	Abilene	D01R1	Stonewall	48433
48033	Borden	Abilene	D01R1	Taylor	48441
48011	Armstrong	Amarillo	D02R1	Armstrong	48011
48011	Armstrong	Amarillo	D02R1	Carson	48065
48011	Armstrong	Amarillo	D02R1	Dallam	48111
48011	Armstrong	Amarillo	D02R1	Deaf Smith	48117
48011	Armstrong	Amarillo	D02R1	Gray	48179
48011	Armstrong	Amarillo	D02R1	Hansford	48195
48011	Armstrong	Amarillo	D02R1	Hartley	48205
48011	Armstrong	Amarillo	D02R1	Hemphill	48211
48011	Armstrong	Amarillo	D02R1	Hutchinson	48233
48011	Armstrong	Amarillo	D02R1	Lipscomb	48295
48011	Armstrong	Amarillo	D02R1	Moore	48341
48011	Armstrong	Amarillo	D02R1	Ochiltree	48357
48011	Armstrong	Amarillo	D02R1	Oldham	48359
48011	Armstrong	Amarillo	D02R1	Potter	48375
48011	Armstrong	Amarillo	D02R1	Randall	48381
48011	Armstrong	Amarillo	D02R1	Roberts	48393
48011	Armstrong	Amarillo	D02R1	Sherman	48421
48037	Bowie	Atlanta	D03R2	Bowie	48037
48037	Bowie	Atlanta	D03R2	Camp	48063
48037	Bowie	Atlanta	D03R2	Cass	48067
48037	Bowie	Atlanta	D03R2	Marion	48315
48037	Bowie	Atlanta	D03R2	Morris	48343
48037	Bowie	Atlanta	D03R2	Panola	48365
48037	Bowie	Atlanta	D03R2	Titus	48449

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48031	Blanco	Austin	D04R1	Blanco	48031
48031	Blanco	Austin	D04R1	Gillespie	48171
48021	Bastrop	Austin	D04R2	Lee	48287
48031	Blanco	Austin	D04R1	Llano	48299
48031	Blanco	Austin	D04R1	Mason	48319
48241	Jasper	Beaumont	D05R2	Jasper	48241
48241	Jasper	Beaumont	D05R2	Newton	48351
48241	Jasper	Beaumont	D05R2	Tyler	48457
48049	Brown	Brownwood	D06R1	Brown	48049
48049	Brown	Brownwood	D06R1	Coleman	48083
48049	Brown	Brownwood	D06R1	Comanche	48093
48049	Brown	Brownwood	D06R1	Eastland	48133
48049	Brown	Brownwood	D06R1	Lampasas	48281
48049	Brown	Brownwood	D06R1	Mc Culloch	48307
48049	Brown	Brownwood	D06R1	Mills	48333
48049	Brown	Brownwood	D06R1	San Saba	48411
48049	Brown	Brownwood	D06R1	Stephens	48429
48041	Brazos	Bryan	D07R2	Brazos	48041
48041	Brazos	Bryan	D07R2	Burleson	48051
48041	Brazos	Bryan	D07R2	Freestone	48161
48041	Brazos	Bryan	D07R2	Grimes	48185
48041	Brazos	Bryan	D07R2	Leon	48289
48041	Brazos	Bryan	D07R2	Madison	48313
48041	Brazos	Bryan	D07R2	Milam	48331
48041	Brazos	Bryan	D07R2	Robertson	48395
48041	Brazos	Bryan	D07R2	Walker	48471
48041	Brazos	Bryan	D07R2	Washington	48477

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48045	Briscoe	Childress	D08R1	Briscoe	48045
48045	Briscoe	Childress	D08R1	Childress	48075
48045	Briscoe	Childress	D08R1	Collingsworth	48087
48045	Briscoe	Childress	D08R1	Cottle	48101
48045	Briscoe	Childress	D08R1	Dickens	48125
48045	Briscoe	Childress	D08R1	Donley	48129
48045	Briscoe	Childress	D08R1	Foard	48155
48045	Briscoe	Childress	D08R1	Hall	48191
48045	Briscoe	Childress	D08R1	Hardeman	48197
48045	Briscoe	Childress	D08R1	King	48269
48045	Briscoe	Childress	D08R1	Knox	48275
48045	Briscoe	Childress	D08R1	Motley	48345
48045	Briscoe	Childress	D08R1	Wheeler	48483
48007	Aransas	CorpusChristi	D09R2	Aransas	48007
48007	Aransas	CorpusChristi	D09R2	Bee	48025
48007	Aransas	CorpusChristi	D09R2	Goliad	48175
48249	JimWells	CorpusChristi	D09R6	Jim Wells	48249
48007	Aransas	CorpusChristi	D09R2	Karnes	48255
48249	JimWells	CorpusChristi	D09R6	Kleberg	48273
48007	Aransas	CorpusChristi	D09R2	Live Oak	48297
48007	Aransas	CorpusChristi	D09R2	Nueces	48355
48007	Aransas	CorpusChristi	D09R2	Refugio	48391
48007	Aransas	CorpusChristi	D09R2	San Patricio	48409
48349	Navarro	Dallas	D10R2	Navarro	48349
48043	Brewster	ElPaso	D11R1	Brewster	48043
48043	Brewster	ElPaso	D11R1	Culberson	48109
48229	Hudspeth	ElPaso	D11R1	Hudspeth	48229
48043	Brewster	ElPaso	D11R1	Jeff Davis	48243
48043	Brewster	ElPaso	D11R1	Presidio	48377
48143	Erath	FortWorth	D12R1	Erath	48143
48143	Erath	FortWorth	D12R1	Jack	48237
48143	Erath	FortWorth	D12R1	Palo Pinto	48363
48221	Hood	FortWorth	D12R2	Somervell	48425

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48127	Dimmit	Laredo	D14R1	Dimmit	48127
48131	Duval	Laredo	D14R6	Duval	48131
48127	Dimmit	Laredo	D14R1	Kinney	48271
48127	Dimmit	Laredo	D14R1	La Salle	48283
48127	Dimmit	Laredo	D14R1	Maverick	48323
48127	Dimmit	Laredo	D14R1	Val Verde	48465
48127	Dimmit	Laredo	D14R1	Webb	48479
48127	Dimmit	Laredo	D14R1	Zavala	48507
48017	Bailey	Lubbock	D15R1	Bailey	48017
48017	Bailey	Lubbock	D15R1	Castro	48069
48017	Bailey	Lubbock	D15R1	Cochran	48079
48017	Bailey	Lubbock	D15R1	Crosby	48107
48017	Bailey	Lubbock	D15R1	Dawson	48115
48017	Bailey	Lubbock	D15R1	Floyd	48153
48017	Bailey	Lubbock	D15R1	Gaines	48165
48017	Bailey	Lubbock	D15R1	Garza	48169
48017	Bailey	Lubbock	D15R1	Hale	48189
48017	Bailey	Lubbock	D15R1	Hockley	48219
48017	Bailey	Lubbock	D15R1	Lamb	48279
48017	Bailey	Lubbock	D15R1	Lubbock	48303
48017	Bailey	Lubbock	D15R1	Lynn	48305
48017	Bailey	Lubbock	D15R1	Parmer	48369
48017	Bailey	Lubbock	D15R1	Swisher	48437
48017	Bailey	Lubbock	D15R1	Terry	48445
48017	Bailey	Lubbock	D15R1	Yoakum	48501
48005	Angelina	Lufkin	D16R2	Angelina	48005
48005	Angelina	Lufkin	D16R2	Houston	48225
48005	Angelina	Lufkin	D16R2	Nacogdoches	48347
48005	Angelina	Lufkin	D16R2	Polk	48373
48005	Angelina	Lufkin	D16R2	Sabine	48403
48005	Angelina	Lufkin	D16R2	San Augustine	48405
48005	Angelina	Lufkin	D16R2	San Jacinto	48407
48005	Angelina	Lufkin	D16R2	Shelby	48419
48005	Angelina	Lufkin	D16R2	Trinity	48455

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48003	Andrews	Odessa	D17R1	Andrews	48003
48003	Andrews	Odessa	D17R1	Crane	48103
48003	Andrews	Odessa	D17R1	Ector	48135
48003	Andrews	Odessa	D17R1	Loving	48301
48003	Andrews	Odessa	D17R1	Martin	48317
48003	Andrews	Odessa	D17R1	Midland	48329
48003	Andrews	Odessa	D17R1	Pecos	48371
48003	Andrews	Odessa	D17R1	Reeves	48389
48003	Andrews	Odessa	D17R1	Terrell	48443
48003	Andrews	Odessa	D17R1	Upton	48461
48003	Andrews	Odessa	D17R1	Ward	48475
48003	Andrews	Odessa	D17R1	Winkler	48495
48119	Delta	Paris	D18R2	Delta	48119
48119	Delta	Paris	D18R2	Fannin	48147
48119	Delta	Paris	D18R2	Franklin	48159
48119	Delta	Paris	D18R2	Grayson	48181
48119	Delta	Paris	D18R2	Hopkins	48223
48119	Delta	Paris	D18R2	Lamar	48277
48119	Delta	Paris	D18R2	Rains	48379
48119	Delta	Paris	D18R2	Red River	48387
48047	Brooks	Pharr	D19R6	Brooks	48047
48047	Brooks	Pharr	D19R6	Cameron	48061
48047	Brooks	Pharr	D19R6	Hidalgo	48215
48047	Brooks	Pharr	D19R6	Jim Hogg	48247
48047	Brooks	Pharr	D19R6	Kenedy	48261
48047	Brooks	Pharr	D19R6	Starr	48427
48047	Brooks	Pharr	D19R6	Willacy	48489
48505	Zapata	Pharr	D19R1	Zapata	48505

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48081	Coke	SanAngelo	D20R1	Coke	48081
48081	Coke	SanAngelo	D20R1	Concho	48095
48081	Coke	SanAngelo	D20R1	Crockett	48105
48081	Coke	SanAngelo	D20R1	Edwards	48137
48081	Coke	SanAngelo	D20R1	Glasscock	48173
48081	Coke	SanAngelo	D20R1	Irion	48235
48081	Coke	SanAngelo	D20R1	Kimble	48267
48081	Coke	SanAngelo	D20R1	Menard	48327
48081	Coke	SanAngelo	D20R1	Reagan	48383
48081	Coke	SanAngelo	D20R1	Real	48385
48081	Coke	SanAngelo	D20R1	Runnels	48399
48081	Coke	SanAngelo	D20R1	Schleicher	48413
48081	Coke	SanAngelo	D20R1	Sterling	48431
48081	Coke	SanAngelo	D20R1	Sutton	48435
48081	Coke	SanAngelo	D20R1	Tom Green	48451
48013	Atascosa	SanAntonio	D21R2	Atascosa	48013
48019	Bandera	SanAntonio	D21R1	Bandera	48019
48019	Bandera	SanAntonio	D21R1	Frio	48163
48019	Bandera	SanAntonio	D21R1	Kerr	48265
48311	McMullen	SanAntonio	D21R6	Mc Mullen	48311
48019	Bandera	SanAntonio	D21R1	Medina	48325
48019	Bandera	SanAntonio	D21R1	Uvalde	48463
48001	Anderson	Tyler	D22R2	Anderson	48001
48001	Anderson	Tyler	D22R2	Cherokee	48073
48001	Anderson	Tyler	D22R2	Henderson	48213
48001	Anderson	Tyler	D22R2	Van Zandt	48467
48001	Anderson	Tyler	D22R2	Wood	48499
48027	Bell	Waco	D23R2	Bell	48027
48027	Bell	Waco	D23R2	Bosque	48035
48027	Bell	Waco	D23R2	Coryell	48099
48027	Bell	Waco	D23R2	Falls	48145
48193	Hamilton	Waco	D23R1	Hamilton	48193
48027	Bell	Waco	D23R2	Hill	48217
48027	Bell	Waco	D23R2	Limestone	48293
48027	Bell	Waco	D23R2	Mc Lennan	48309

GroupID	GroupName	DistrictName	Codescombination	CountyName	CountyID
48009	Archer	WichitaFalls	D24R1	Archer	48009
48009	Archer	WichitaFalls	D24R1	Baylor	48023
48009	Archer	WichitaFalls	D24R1	Clay	48077
48097	Cooke	WichitaFalls	D24R2	Cooke	48097
48009	Archer	WichitaFalls	D24R1	Montague	48337
48009	Archer	WichitaFalls	D24R1	Throckmorton	48447
48009	Archer	WichitaFalls	D24R1	Wichita	48485
48009	Archer	WichitaFalls	D24R1	Wilbarger	48487
48009	Archer	WichitaFalls	D24R1	Young	48503
48015	Austin	Yoakum	D25R2	Austin	48015
48015	Austin	Yoakum	D25R2	Calhoun	48057
48015	Austin	Yoakum	D25R2	Colorado	48089
48015	Austin	Yoakum	D25R2	De Witt	48123
48015	Austin	Yoakum	D25R2	Fayette	48149
48015	Austin	Yoakum	D25R2	Gonzales	48177
48015	Austin	Yoakum	D25R2	Jackson	48239
48015	Austin	Yoakum	D25R2	Lavaca	48285
48015	Austin	Yoakum	D25R2	Matagorda	48321
48015	Austin	Yoakum	D25R2	Victoria	48469
48015	Austin	Yoakum	D25R2	Wharton	48481

[1] The 34 final adjusted rates GroupIDs (output from MOVESratesadj utility, which filtered pollutants for input to emissions calculations, and adjusted for TxLED NO_x effects, where applicable), are the five character county FIPS codes of the county representing each group (essentially the first county of each group, alphanumerically).

[2] The first three characters of the codescombination (fourth column) identify the TxDOT district (i.e., D1 through D25). The last two characters in the codescombination shows associated fuels regions (R1 through R6, consistent with the six MOVES fuel regions for Texas), and if TxLED NOx adjustments were applied (R1, R3, and R6 groups were not TxLED adjusted, and R2, R4, and R5 groups were adjusted for TxLED.

APPENDIX B:
EMISSIONS ESTIMATION UTILITIES FOR MOVES-BASED EMISSIONS INVENTORIES

TTI EMISSIONS ESTIMATION UTILITIES FOR MOVES2014-BASED EMISSIONS INVENTORIES

The following is a summary of utilities developed by TTI (written in the Visual Basic programming language) for producing detailed, link-based, hourly, and 24-hour emissions estimates for on-road mobile sources using the latest version of EPA's MOVES model (MOVES2014). These utilities produce inputs used with the MOVES model, make special adjustments to the emissions factors (when required), and multiply them with travel model link-based or Highway Performance Monitoring System (HPMS)-based (virtual link) activity estimates to produce emissions at user-specified temporal and spatial scales.

The main utilities for calculating hourly and 24-hour emissions using MOVES are TRANSVMT, VirtualLinkVMT, VehPopulationBuild, OffNetActCalc, MOVESactivityInputBuild, MOVESfleetInputBuild, RatesCalc, RatesAdj, and EmsCalc. The TRANSVMT and VirtualLinkVMT prepare the link VMT and speeds activity input. The VehPopulationBuild utility builds the vehicle population used to calculate the off-network activity. The OffNetActCalc utility builds the SHP, starts, SHI, and APU hours required to estimate emissions using the rate-per-activity emissions rates produced by the RatesCalc or RatesAdj utilities. The MOVESactivityInputBuild and MOVESfleetInputBuild utilities build inputs used in MOVES. The RatesCalc utility assembles the emissions rates from the MOVES output in terms of rate-per-activity, including rate-per-SHP for the evaporative emissions processes. The RatesAdj utility makes special adjustments to the emissions rates when required. The EmsCalc utility calculates emissions by hourly time periods, producing a tab-delimited summary file (including 24-hour totals), hourly link emissions output files (optional), and an optional tab-delimited summary file by MOVES source classification code (SCC).

A process flow diagram follows the utility descriptions.

TRANSVMT

The TRANSVMT utility post-processes travel demand models (TDMs) to produce hourly, on-road vehicle, seasonal and day-of-week specific, directional link VMT, and speed estimates. The TRANSVMT utility processes a TDM traffic assignment by multiplying the link volumes by the appropriate HPMS, seasonal, or other VMT factors. Hourly factors are then used to distribute the link VMT to each hour in the day. The TTI speed model is used to estimate the operational time-of-day link speeds for each direction. Since intrazonal links are not included in the TDM, special intrazonal links are created and the VMT and speeds for these special links are estimated using the intrazonal trips from the trip matrix and the zonal radii. The link VMT and speeds produced by TRANSVMT are subsequently input to the EmsCalc utility for applying the MOVES-based emissions factors (as well as with other utilities to develop off-network activity estimates).

VirtualLinkVMT

The VirtualLinkVMT utility post-processes county HPMS average annual daily traffic (AADT) VMT, centerline miles, and lane miles by functional classification and area type (from the Texas Department of Transportation's [TxDOT's] annual Roadway Inventory Functional Classification Record [RIFCREC]) to produce hourly, on-road vehicle fleet, seasonal and day-of-week specific actual or projected VMT, and directional operational speed estimates. These estimated VMT and speeds are produced for up to 42 directional HPMS functional classification/area type combinations, or “links.” The VirtualLinkVMT utility was developed for use in areas that do not have TDM networks, as well as for inventory applications for which network link-based detail is not required. The main inputs to VirtualLinkVMT are:

- County HPMS data sets, which include AADT VMT, centerline miles, and lane miles by HPMS area type and functional class;
- County-level VMT control totals;
- Hourly VMT distributions; and
- Speed model inputs to include volume/delay equation parameters adapted for HPMS, and free-flow speeds and lane capacities by HPMS functional classification and area type.

VirtualLinkVMT initially scales the county HPMS AADT VMT at the link level to the appropriate VMT (e.g., uses a county-level VMT control total-to-AADT ratio to produce seasonal, day-of-week specific VMT). Hourly factors and directional split factors are applied to the adjusted VMT on each link to estimate the hourly, directional VMT (and volumes) by HPMS link. Congested speed models, each for the high- and low-capacity links, are used to estimate the hourly operational speeds by direction for each link. The operational speeds are based on volume/capacity (v/c)-derived directional delay (minutes/mile) applied to the estimated free-flow speeds for each link. The virtual link VMT and speeds produced using the VirtualLinkVMT utility are an input to the emissions calculation utility, EmsCalc (as well as with other utilities to develop off-network activity estimates).

VehPopulationBuild

The VehPopulationBuild utility builds the sourcetypeyear data files in a format consistent with the MOVES input database table and the SUT/fuel type population input file (can be used with the EmsCalc utility to estimate emissions or the OffNetActCalc utility to estimate starts and SHP) using the VMT mix and the Texas Department of Motor Vehicles (TxDMV) registration data sets. The TxDMV registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- County ID file, which specifies the county for which the output will be calculated;
- Age registration data file, which lists 31 years of registration data for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, Gas >60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000, and Diesel Totals diesel truck categories;

- VMT mix by TxDOT district, MOVES SUT, and MOVES fuel type;
- TxDOT district name file, which specifies the VMT mix TxDOT district;
- MOVES default database;
- Population factor file (optional); and
- Year ID file (optional, only used if population factors are used), which specifies the year for calculating the output.

For the desired county (from the county ID file), the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas >8500, Gas >10000, Gas >14000, Gas >16000, Gas >19500, Gas >26000, Gas >33000, and Gas >60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000, Diesel >19500, Diesel >26000, Diesel >33000, and Diesel >60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array. The age registration data array and the diesel/gas registration data array are combined to form the registration category data array (seven categories for 31 years of data and the total) using the combinations in Table 36.

Table 36. Registration Categories.

Registration Category	Vehicle Category	Data Location
1	Passenger Vehicle	Age registration data array
2	Motorcycles	
3	Total Trucks <=8500	
4	Diesel >8500, Diesel >10000, Diesel >14000, Diesel >16000	Diesel/gas registration data array
5	Diesel >19500, Diesel >26000, Diesel >33000, Diesel >60000	
6	Gas >8500, Gas >10000, Gas >14000, Gas >16000	
7	Gas >19500, Gas >26000, Gas >33000, Gas >60000	

The registration category data array is used to fill the SUT population array (by SUT and fuel type) for all vehicles except long-haul trucks. Each SUT/fuel type combination is assigned the total registrations from one or more of the registration categories in the registration category data array. Table 37 shows the SUTs and their associated registration category in the registration category data array.

Table 37. SUT/Registration Category Correlation.

SUT	Registration Category
11	2
21	1
31, 32	3
41, 42, 43, 51, 52, 54	4 + 6
61	5 + 7

SUT population factors are calculated by SUT/fuel type using the data from the VMT mix input for all SUTs except motorcycles (SUT 11) and the long-haul trucks (SUTs 53 and 62) and saved in the SUT population factors array. For SUT 21, the fuel type VMT mix is divided by the total VMT mix for SUT 21. For SUT 31, the fuel type VMT mix is divided by the total VMT mix for SUTs 31 and 32. The same process applies to SUT 32. For SUT 41, the fuel type VMT mix is divided by the total VMT mix for SUTs 41, 42, 43, 51, 52, and 54. The same process applies to SUTs 42, 43, 51, 52, and 54. For SUT 61, the fuel type VMT mix is divided by the total VMT mix for SUT 61.

For SUT 11, the SUT population factor for fuel type 1 (gasoline) is set 1 with all other factors set to 0. For SUT 53, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 53 by the fuel type VMT mix for SUT 52. For SUT 62, the SUT population factors by fuel type are calculated by dividing the fuel type VMT mix for SUT 62 by the fuel type VMT mix for SUT 61, therefore creating a ratio of long-haul and short-haul trucks.

The SUT population factors and the population factor (if desired) are applied to the SUT population array for all SUTs except SUT 53 and 62. For SUT 53, the SUT population factors for SUT 53 are applied to the SUT population array for SUT 52. For SUT 62, the SUT population factors for SUT 62 are applied to the SUT population array for SUT 61.

Using the appropriate MySQL code, a new sourcetypeyear database table is created. The data in the SUT population array is aggregated by fuel type and used to fill the sourcetypeyear database table, along with the yearID, salesGrowthFactor, and migrationrate. For the yearID, the year of the registration data is used, unless a population factor is used, in which case the year from the year ID input is used. The salesGrowthFactor and migrationrate for each SUT is set 1. A text format of this database table is written by the utility as well. The SUT/fuel type population input file is written using the SUT population array.

OffNetActCalc

The OffNetActCalc calculates the analysis scenario (i.e., year, season, day type) SHP, starts, SHI, and APU hours by hour, SUT, and fuel type used to estimate emissions using the EmsCalc utility. The SHI and APU hours are only calculated for SUT 62, fuel type 2 (CLhT_Diesel). The SHP is calculated using either the TDM or the virtual link-based link VMT and speeds (same as used in the distance-based emissions estimation), the 24-hour or time period VMT mix (by roadway type and SUT/fuel type), and the SUT/fuel type population (from the VehiclePopulationBuild utility). The starts activity is calculated using the SUT/fuel type population and the starts per vehicle (typically the MOVES default). The SHI and APU hours are a function of hotelling hours. This utility has two options for calculating the hotelling hours. Using the first option, the analysis scenario 24-hour hotelling hours is calculated using a user-supplied extended idle factor to the source hours operating (SHO). However, this method of estimating the hotelling hours as a direct function of the SHO does not consider the availability of locations where extended idling may occur. The second option (and suggested method) uses base data (24-hour hotelling, link VMT and speeds, and VMT mix), the analysis scenario data used to calculate the SHP, and the analysis scenario SHP to calculate the analysis scenario 24-hour hotelling hours.

For the analysis scenario first hourly VMT and speeds input, the utility applies the appropriate VMT mix (either the 24-hour VMT mix or the appropriate time period VMT mix as assigned by the user) to each link that has the desired county code; thus distributing the link VMT to each SUT/fuel type, which is added to the hourly SUT/fuel type VMT. The link VMT by SUT/fuel type is divided by the link speed to calculate the link VHT (or SHO) by SUT/fuel type, which is added to the SUT fuel/type VHT. This calculation process is repeated for each analysis scenario VMT and speeds input; therefore producing the analysis scenario hourly values for VMT by SUT/fuel type and for VHT by SUT/fuel type.

The analysis scenario hourly SUT/fuel type speed, total hours (or source hours), and SHP are then calculated. For each hour and SUT/fuel type, the hourly SUT/fuel type VMT is divided by the hourly SUT/fuel type VHT to calculate the hourly SUT/fuel type speed. The hourly SUT/fuel type total hours are set equal to the SUT/fuel type population. The hourly SUT/fuel type SHP is calculated by subtracting the hourly SUT/fuel type VHT (or SHO) from the hourly SUT/fuel type total hours. If the calculated SHP is negative (i.e., SHO is greater than the total hours), the SHP is set to 0.

To calculate the analysis scenario 24-hour hotelling hours under option 1 (as a direct function of SHO), the utility multiplies the CLhT_Diesel analysis scenario 24-hour SHO by the user-supplied extended idle factor, which represents the amount of extended idle time that must occur per SHO. For option 2 (as a function of base hotelling data), the utility calculates the base 24-hour CLhT_Diesel VMT using the base VMT and speeds inputs and the base VMT mix with the same procedure used in the analysis scenario SHP calculations. The 24-hour analysis scenario CLhT_Diesel VMT is then divided by the 24-hour base CLhT_Diesel VMT to create a scaling factor, which is then applied to the base 24-hour hotelling hours to calculate the analysis scenario 24-hour hotelling hours.

The utility then calculates the analysis scenario hourly hotelling hours. The analysis scenario hourly CLhT_Diesel SHO (from the SHP calculation process) is converted to hourly VHT fractions. The hourly hotelling fractions are calculated as the inverse of the hourly VHT fractions. The hourly hotelling fractions are then applied to the analysis scenario 24-hour hotelling hours to calculate the hourly hotelling hours. For each hour, the hourly hotelling hours are then compared to the hourly CLhT_Diesel SHP. For those hours where the hotelling hours are greater than the SHP, hotelling hours are set to the SHP for that hour.

The utility then calculates the SHI fraction and the APU fraction using the source type age distribution (same distribution used in the MOVES runs), the relative mileage accumulation rates, and the hotelling activity distribution. Travel fractions for SUT 62 (CLhT) by ageID (0 through 30) are calculated by multiplying the age distribution by the appropriate relative mileage accumulation rate, which is then converted into a distribution by dividing the individual travel fraction (ageID 0 through 30) by the sum of the travel fractions. These travel fractions are then applied to the appropriate operating mode fractions from the hotelling activity distribution (operating mode 200) and summed to calculate the SHI fraction. Using a similar process, the APU fraction is calculated using the operating mode fractions for operating mode 201. For each hour the analysis scenario hotelling hours are multiplied by the SHI fraction to calculate the analysis scenario SHI activity and by the APU fraction to calculate the analysis scenario APU hours.

MOVESactivityInputBuild

The MOVESactivityInputBuild utility builds the roadtypedistribution, hourvmtfraction, avgspeeddistribution, roadtype, hpmsvtypeyear, year, state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction data files in a format consistent with the MOVES input database tables using the link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility, the VMT mix, and the MOVES defaults. The primary inputs to this utility are:

- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility;
- County ID file which specifies the county number in the link-based hourly VMT and speeds for which the output will be calculated;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types (same as used with the EmsCalc utility);
- 24-hour or time period VMT mix by roadway type, MOVES source type, and MOVES fuel type (same as used with the EmsCalc utility);
- Day ID, which specifies the MOVES day ID for calculating the output;
- Year ID, which specifies the year for calculating the output;
- Link/Ramp designations, which designates each link roadway type/area type combination to either ramp or non-ramp; and
- MOVES default database.

For each link in the link-based hourly VMT and speeds in which the county number matches the desired county ID, the link VMT is saved in a VMT summary array based on hour, link functional class, and link area type. The link VHT (link VMT/link speed) is saved in a VHT summary array based on hour, link functional class, link area type, and MOVES average speed bin ID (determined using the MOVES average speed bins and the link speed). The link VHT is also saved in a road type VHT array based on link functional class and link area type, and, if the link is specified as ramp by the link/ramp designations specified by the user, the VHT is additionally saved in the ramp segment of the road type VHT array.

A MOVES roadway type array by MOVES roadway type (roadTypeID codes 2 through 5) is also created using the data in the VMT summary array and VMT roadway type designations. For the link road types designated a MOVES road type of 6 or 8, the VMT is added to MOVES road type 2 in the MOVES roadway type array. For the link road types designated a MOVES road type of 7 or 9, the VMT is added to MOVES road type 4 in the MOVES roadway type array. An hourly VMT array (by MOVES SUT, MOVES roadway type, and hour) is formed using the data in the VMT summary array, the VMT roadway type designations, and the VMT mix. If the time period VMT mix is used, each hour is assigned a time period by the user. Otherwise, the same 24-hour VMT mix is used for all hours. An average speed distribution array (by MOVES SUT, MOVES roadway type, hour, and MOVES speed bin) is created using the VHT summary array and the VMT mix. Using the appropriate MySQL code, the MOVES roadtypedistribution, hourvmtfraction, and avgspeeddistribution default values are extracted and saved for later use.

The VMT in the MOVES roadway type array is used to produce the roadway type distribution array by MOVES SUT and MOVES roadway type. This VMT is converted to a distribution by MOVES SUT (i.e., the total for a SUT over the five MOVES roadway types should equal 1), with the distribution value for MOVES roadway type 0 (Off-Network) equal to 0. Using the appropriate MySQL code, the roadtypedistribution database table is written. A tab-delimited version is also written (optional).

The VMT in the hourly VMT array is added to the hourly VMT fraction array (by SUT, MOVES roadway type, and hour) and for those roadway types where the VMT for all hours is greater than 0, this VMT is converted to an hourly distribution. For those roadway types where the VMT is equal to 0, a value of 1 is placed in the first hour, followed by 0 in the remaining hours. Using the appropriate MySQL code, the hourvmtfraction database table is written. For those SUTs where the VMT mix is greater than 0, the hourly VMT fraction array is used. Otherwise, the MOVES hourvmtfraction default values are used. A tab-delimited version is also written (optional).

The VHT in the average speed distribution array is converted to a distribution by SUT, MOVES roadway type, hour/day (combination of hour and the day ID specified by the user), and MOVES average speed bin. Using the appropriate MySQL code, the avgspeeddistribution database table is written. For those SUTs where the VMT mix is greater than 0, the average speed distribution array is used. Otherwise, the MOVES avgspeeddistribution default values are used. A tab-delimited version is also written (optional).

The VHT in the road type VHT array is converted to a proportion of ramp VHT by dividing the ramp segment of the road type VHT array by the total VHT for the road type in the road type VHT. Using the appropriate MySQL code, the roadtype database table is written using the proportions from the road type VHT array. If the ramp fraction for roadTypeID 2 is greater than 0, then roadTypeID 6 (with rampFraction equal to 0) and roadTypeID 8 (with rampFraction equal to 1) are also added to the roadtype database table. If the ramp fraction for roadTypeID 4 is greater than 0, then roadTypeID 7 (with rampFraction equal to 0) and roadTypeID 9 (with rampFraction equal to 1) are also added to the roadtype database table. A tab-delimited version is also written (optional).

The VMT in the hourly VMT array is aggregated to create the HPMS vehicle type VMT array. Each SUT is assigned an HPMS vehicle type (SUT 11 is HPMS vehicle type 10; SUTs 21, 31 and 32 are HPMS vehicle type 25; SUTs 41, 42, and 43 are HPMS vehicle type 40; SUTs 51, 52, 53, and 54 are HPMS vehicle type 50; and SUTs 61 and 62 are HPMS vehicle type 60). Using the appropriate MySQL code, the hpmsvtypeyear database table is written using the VMT from the HPMS vehicle type VMT array, along with the user supplied year ID, the VMT growth factor (automatically set to "Null"), and the base year Off-Network VMT (automatically set to 0). A tab-delimited version is also written (optional).

Using the appropriate MySQL code, the fuel year ID is extracted from the MOVES default year database table for the user-supplied year ID and the new year database table is written using the user-supplied year ID and the extracted fuel year ID. The "isbaseYear" data is written as well (automatically set to "Y"). A tab-delimited version is also written (optional).

The utility also produces two tab-delimited summary output files. A tab-delimited VMT summary is output by hour, link road type, and link area type for the user-specified county. A tab-delimited VHT summary is output by hour, link road type, link area type, and MOVES average speed bin for the user-specified county.

The utility outputs five other database tables (state, zone, zoneroadtype, monthvmtfraction, and dayvmtfraction) using the appropriate MySQL code and the user-supplied inputs. For the state database table, a new state database table is created and the data from the MOVES default state database table is copied to the new table for the state ID of 48. For the zone database table, a new zone database table is created and the data from the MOVES default zone data base table is copied to the new table for the county ID greater than 48000 and county ID less than 49000. The start allocation factors, idle allocation factors, and SHP allocation factors are all then replaced with values of 1 in the new table.

For the zoneroadtype database table, a new zoneroadtype database table is created and the data from the MOVES default zoneroadtype data base table is copied to the new table for the zone ID greater than 480000 and zone ID less than 490000. The SHO allocation factors are all then replaced with values of 1 in the new table. For the monthvmtfraction database table, a new monthvmtfraction database table is created and the data from the MOVES default monthvmtfraction database table is copied to the new database table and the month VMT fraction is set to 1 for the user-supplied month ID and 0 for all other months. For the dayvmtfraction database table, a new dayvmtfraction database table is created and the data from the MOVES default dayvmtfraction database table is copied to the new table and the day VMT fraction is set to 1 for the user-supplied day ID and 0 for all other months.

MOVESfleetInputBuild

The MOVESfleetInputBuild utility builds the sourcetypeagedistribution database table and fuel/engine fraction inputs to MOVES using the TxDOT registration data sets and the MOVES default database tables. The TxDOT registration data sets are three sets of registration data (an age registration data file, a gas trucks registration data file, and a diesel trucks registration data file) that list 31 years of registration data. The primary inputs to this utility are:

- Age registration data file, which lists 31 years of registration data for the Passenger Vehicles, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, Total Trucks <=8500, Gas Trucks >8500, Diesel Trucks >8500, Total Trucks >8500, and Total All Trucks vehicle categories;
- Gas trucks registration data file, which lists 31 years of registration data for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, Gas > 60000, and Gas Totals gas truck categories;
- Diesel trucks registration data file, which lists 31 years of registration data for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, Diesel > 60000, and Diesel Totals diesel truck categories;
- SUT data sources input, which specifies the data source for each SUT to use when building the souretypeagedistribution database table;
- Fuel/engine fractions data sources input, which specifies the data source for each SUT to use when building the fuel/engine fractions;
- Default sourcetypeage distribution input;
- MOVES default database; and
- Year ID file (optional, only if year is not the registration data year as in a future year analysis), which specifies the year for calculating the output.

The SUT data sources input lists the data source for each SUT, either a single county, multiple counties, state, or MOVES default. As this input is processed, the utility maintains a list of the input sources. The same applies to the fuel/engine fractions, except data source inputs are only valid for source types 52, 53, and 61 (other are not valid due to data limitations and source type 62 are all considered diesel).

For each county (or state total) in the list of the input sources, the age registration data (for the Passenger Vehicle, Motorcycles, Trucks <=6000, Trucks >6000 <=8500, and Total Trucks <=8500 vehicle categories) are saved in an age registration data array. The gas truck registration data (for the Gas > 8500, Gas > 10000, Gas > 14000, Gas > 16000, Gas > 19500, Gas > 26000, Gas > 33000, and Gas > 60000 gas truck categories) are saved in the gas truck section of the diesel/gas registration data array. The diesel truck registration data (for the Diesel > 8500, Diesel > 10000, Diesel > 14000, Diesel > 16000, Diesel > 19500, Diesel > 26000, Diesel > 33000, and Diesel > 60000 diesel truck categories) are saved in the diesel truck section of the diesel/gas registration data array.

The age registration data array and the diesel/gas registration data array are combined to create the registration category data array (a total of seven categories for 31 years of data and the total) using the combinations in Table 36 (Registration Categories**)**. The county is compared to the data sources for each SUT in the SUT data sources input. If the county is found for a given source type, then the 31 years of registration data from the source type's corresponding category in the registration category data array are added to the SUT age distribution array. Table 38 shows the source types and their corresponding registration categories.

Table 38. SUTs/Registration Categories Correlation for SUT Age Distribution.

SUT	Registration Category
11	2
21	1
31, 32	3
52, 53	4
61, 62	5

A similar process is followed for the fuel/engine fractions array. However, only SUTs 52, 53, 61, and 62 are processed due to data limitations. The registration data are saved in the fuel/engine fractions array based on fuel type. Table 39 shows the SUTs and their corresponding registration categories.

Table 39. SUTs/Registration Categories Correlation for Fuel/Engine Fractions.

SUT	Fuel Type	Registration Category
52, 53	Diesel	4
	Gas	6
61	Diesel	5
	Gas	7
62	Diesel	5 + 7
	Gas	None – all are assumed diesel

After processing all of the counties, the data from the default sourcetypeage distribution input are processed and the data for the registration data year are saved in the default age distribution array. For each source type in which the registration data are to be used for the age distribution, the 31 years of registration data in the SUT age distribution array are converted to a distribution by dividing the source type yearly registration data by the source type total registration data. For each source type in which the defaults are to be used, the defaults values from the default age distribution array are copied to the SUT age distribution array.

The MOVES default fuel/engine fractions are extracted from the MOVES default database (using the appropriate code for MySQL) and saved in the default fuel/engine fractions array. For source types 52, 53, and 61, the source type yearly registration data in the fuel/engine fractions array are converted to fuel/engine fractions by dividing the yearly source type diesel registration data by the sum of the yearly source type diesel registration data and the yearly source type gas registration data.

If the year ID input is used, then these fuel/engine fractions are adjusted to match the year from the year ID input. If the year from the year ID input is greater than the registration data year, then the first fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the end of the fuel/engine fractions to maintain the appropriate distribution. If the year from the year ID input is less than the registration data year, then the last fuel/engine fraction is extended to match the year from the year ID input and the appropriate number of years is dropped from the beginning of the fuel/engine fractions to maintain the appropriate distribution. For source type 62, all of the fuel/engine fractions in the fuel/engine fractions array are set to a value of 1.

Using the appropriate MySQL code, a new sourcetypeagedistribution database table is created and the data from the SUT age distribution array, along with the year ID (either from the registration data or the year ID input), are used to fill the new database table. A text format of this database table may be written as well. Using the appropriate MySQL code, a new AVFTfuelengfraction database table is created and the data from the fuel/engine fractions array are used to fill the new database table for SUTs 52, 53, 61, and 62. For all other SUTs, the default fuel/engine fraction array data for the appropriate year (either the registration data year or the year ID input) are used to fill the new database table. A text format of this database table may be written as well.

RatesCalc

The RatesCalc utility calculates emissions rates in terms of rate/SHP for the evaporative emissions processes using the data in the CDB used in the MOVES emissions rates run and the MOVES default database. The utility also creates copies of the rateperdistance, rateperhour, rateperstart, rateperprofile (optional), and ratepervehicle (optional) emissions rate tables to include the units for each pollutant. If not specified, emissions rates are assembled for each pollutant and process combination (excluding total energy and the refueling emissions processes) in the MOVES emissions rate tables. The utility also uses the movesrun database table, along with a pollutant energy or mass lookup table (mass, TEQ, or gmole), to determine the units of the emissions rates, which are added to the emissions rate tables, which will allow the user to specify any of the units available in MOVES for the MOVES emissions rate run. The type of activity used for the emissions rate calculation is determined by the process, as Table 40 shows.

Table 40. MOVES2014 Emissions Process and Corresponding Activity for Rate-per-Activity Emissions Rates.

MOVES2014 Emissions Process	Activity	Emissions Rate Units
Running Exhaust	Miles Traveled	Rate/Mile
Crankcase Running Exhaust	Miles Traveled	Rate/Mile
Start Exhaust	Starts	Rate/Start
Crankcase Start Exhaust	Starts	Rate/Start
Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Crankcase Extended Idle Exhaust	Extended Idle Hours	Rate/Extended Idle Hour
Auxiliary Power Exhaust	APU Hours	Rate/APU Hour
Evaporative Permeation	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Vapor Venting	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Evaporative Fuel Leaks	Miles Traveled Source Hours Parked	Rate/Mile Rate/SHP
Brake Wear	Miles Traveled	Rate/Mile
Tire Wear	Miles Traveled	Rate/Mile

For the rateperdistance (rate/mile emissions rates) emissions rate table, the utility creates a copy of the emissions rates in the specified output database with the table name ttirateperdistance. If specific pollutants are specified, only the emissions rates for those pollutants are copied to the ttirateperdistance table. Otherwise, the entire rateperdistance table is copied to the ttirateperdistance table. The utility also adds a "Units_Per_Activity" field to the ttirateperdistance table and fills that field based on the pollutants energy or mass designation (mass, TEQ, or gmole). For those pollutants designated as mass, the mass units from the movesrun table are added to the "Units_Per_Activity" field. For those pollutants designated as gmole, the mass units from the movesrun table, along with the text "-mole" (i.e., pound-mole or gram-mole) are added to the "Units_Per_Activity" field. For those pollutants designated as TEQ, the text "TEQ" is added to the "Units_Per_Activity" field. No unit conversions are performed in this utility. The rateperstart, rateperhour, rateperprofile (optional), and ratepervehicle (optional) emissions rate tables are processed in a similar manner to produce the ttirateperstart, ttirateperhour, ttirateperprofile, and ttiratepervehicle emissions rate tables.

The utility also includes a crankcase extended idle flag, which signals the utility how to calculate the crankcase extended idle emissions rates. If these emissions rates are not included in the rateperhour emissions rate table (as was the case with the July 2014 release of MOVES2014), then the flag is set to "YES" or the crankcase extended idle rates will not be included the emissions rates. In this case, the utility creates a copy of the crankcase extended idle emissions rates in the baserateoutput table (located in the output database of the MOVES run) and places them in the ttirateperhour table. If these rates are included in the ratperhour emissions rate table, the flag should be set to "NO" and no other processing is performed by the utility.

For the evaporative emissions rates, the utility uses the CDB from the MOVES run and the MOVES default database to replicate the MOVES vehicle population and SHP calculation process. Using the emissions rates from the rateperprofile and ratepervehicle emissions rate tables, the utility calculates the rate-per-SHP emissions rates by multiplying the emissions rate by the appropriate vehicle population and dividing by the appropriate SHP value. These rate-per-SHP emissions rates are then saved in the ttiratepershp emissions rate table. Similar to the previous RatesCalc emissions rate tables, the "Units_Per_Activity" field is added to the ttiratepershp table and filled based on the pollutants energy or mass designation.

RatesAdj

The RatesAdj utility applies emissions rate adjustments to an emissions rate database table produced by RatesCalc utility (ttirateperdistance, ttirateperstart, ttirateperhour, ttiratepershp, ttiratepervehicle or ttirateperprofile) or by this utility to produce a new emissions rate database table in the same format as the input emissions rate database table. The emissions rate adjustments can be linear adjustments that are applied to all emissions rates or can be applied by SUT, fuel type, pollutant, and process (adjustments may also include roadway type, average speed bin, and hour). The user has the option of selecting which pollutants will be in the new emissions rate database table, along with the output units of the emissions rates. This allows the user to perform any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) without providing any addition adjustment factors. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility. These types of conversions must be made using the emissions rate adjustment factors. The utility also has the option for combining multiple emissions rate database tables into one new emissions rate database table, if the input emissions rate database tables are in the same format.

For the first input emissions rate database table, the utility extracts the emissions rates for the specified pollutants (or all the pollutants if not specified) from the input database emissions rate table, applies the emissions rate adjustments (if necessary) and any unit conversion adjustments, and saves these adjusted emissions rates. If more than one emissions rate database table is input, then the utility performs a similar calculation process to the first input emissions rate database table for each input emissions rate database table. If pollutants are found in more than one input emissions rate database table, the adjusted emissions rates are summed to produce one emissions rate.

After processing all of the input emissions rate database tables, the utility creates a new emissions rate database table in the same format as the first input emissions rate database table and writes the adjusted emissions rates to this new emissions rate database table. Using MySQL code, the utility also creates a minimum and maximum emissions rate summary for each input emissions rate table and the output emissions rate table by pollutant, process, and source type/fuel type, which is written to a tab-delimited file specified by the user.

EmsCalc

The EmsCalc utility estimates the hourly link emissions for one user-specified county using the emissions factors (either from RatesCalc or RatesAdj), the 24-hour or time period VMT mix, the hourly link VMT and speeds activity estimates (either from TRANSVMT or VirtualLinkVMT), and the off-network activity (either vehicle population or SHP, starts, and SHI). This utility produces a tab-delimited output summary (including hourly and 24-hour totals) and hourly link emissions output files (optional). The primary inputs to MOVESemscalc are:

- Emissions factors from RatesCalc or RatesAdj;
- Link-based hourly VMT and speeds developed with the TRANSVMT or VirtualLinkVMT utility. For each link, the following information is input to MOVESemscalc: link start node, link end node, link county number, link roadway type number, link area type number, link VMT, and link operational speed estimate;
- 24-hour or time period VMT mix by roadway type, MOVES SUT, and MOVES fuel type;
- Off-network activity. If the emissions factors are in grams-per-vehicle (i.e., the ttiratepervehicle or ttirateperprofile emissions rates), then vehicle population by SUT/fuel type is required. If the emissions factors are in grams-per-activity (i.e., the ttirateperstart, ttirateperhour, or ttiratepershp emissions rates), then the SHP, starts, SHI, and APU hours by hour and SUT/fuel type are required;
- VMT roadway type designations, which lists associations of the link roadway types/area type combination to the VMT mix, emissions rate, and MOVES roadway types;
- Pollutants input file, which specifies which pollutant/process combinations for which the emissions calculations will be performed and their respective units in the tab-delimited output; and
- SCC input file (optional, only if the activity and emissions by SCC are to be created).

The emissions estimation can be categorized by two basic types based on the type of emissions factors: the roadway-based emissions and the off-network-based emissions. For the roadway-based emissions (ttirateperdistance emissions factors), the VMT for each link is distributed to each of the SUT/fuel type combinations listed in the VMT mix by roadway type (as designated in the VMT roadway type designations). If the time period VMT mix is input, each hour is assigned a time period by the user. Otherwise, the 24-hour VMT mix is used for all hours. For each pollutant/process combination in the pollutants input file, the emissions factors are selected based on the emissions rate roadway type (as designated in the VMT roadway type designations) and the link speed for each SUT/fuel type combinations listed in the VMT mix. For link speeds greater than 75 mph, the emissions factors for 75 mph are used. For link speeds less than 2.5 mph, the emissions factors for 2.5 mph are used. For those link speeds that fall between the 16 MOVES speeds, the emissions factors are interpolated using the emissions factor interpolation methodology in the following section. These SUT/fuel type combination-specific emissions factors are multiplied by the SUT/fuel type combination-specific VMT to estimate the mobile source emissions for that link by SUT/fuel type combination. If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file.

The off-network emissions calculation depends on the format of the input emissions factors. If the emissions factors are the ttiratepervehicle or ttirateperprofile emissions rates, the emissions factors by SUT/fuel type are multiplied by their associated vehicle population to estimate emissions. If the emissions factors are the ttirateperstart, ttirateperhour, or ttiratepershp emissions rates, the emissions factors by SUT/fuel type are multiplied by the appropriate activity, which is determined by the emissions process (see Table 40). If the activity and emissions by SCC are to be created, the activity and emissions are also aggregated by SCC using the SCC input file.

The emissions estimates are output in a tab-delimited file (including all of the SUT/fuel type combinations listed in the VMT mix on a single line, separated by a tab character) for the specified county by pollutant, link roadway type, and SUT/fuel type combination for each of the specified episode time periods. A 24-hour (or total if all 24 hours are not specified) output is also included in the tab-delimited file. Only those pollutant/process combinations in the pollutants input file with tab-delimited output units other than "NONE" will appear in the tab-delimited output file. Prior to output, any unit conversions between mass units (i.e., pounds to grams or pound-mole to gram-mole) are performed by the utility. Unit conversions between unit types (i.e., gram-moles to grams or TEQ to grams) are not performed internally by the utility (these type of unit conversions must be done using the RatesAdj utility). This tab-delimited file also includes hourly and 24-hour summaries of the off-network activity and VMT, VHT, and speed by link road type. Link emissions may also be output by county, pollutant, process, and each SUT/fuel type combination. If specified, the tab-delimited activity and emissions by SCC output file is also created, which lists the activity and emissions for each pollutant by SCC.

Emissions Factor Interpolation Methodology

To calculate emissions factors for link speeds that fall between two of the 16 MOVES speed bin speeds, an interpolation methodology similar to the methodology used with MOBILE6 is used. This methodology interpolates each emissions factor using a factor developed from the inverse link speed and the inverse high and low bounding speed bin speeds. The following is an example for a link speed of 41.2 mph.

The interpolated emissions factor (EF_{Interp}) is expressed as:

$$EF_{Interp} = EF_{LowSpeed} - FAC_{Interp} \times (EF_{LowSpeed} - EF_{HighSpeed})$$

Where:

$EF_{LowSpeed}$ = emissions factor (EF) corresponding to the speed below the link speed;

$EF_{HighSpeed}$ = EF corresponding to the speed above the link speed; and

$$FAC_{Interp} = \left(\frac{1}{Speed_{link}} - \frac{1}{Speed_{low}}\right) \Big/ \left(\frac{1}{Speed_{high}} - \frac{1}{Speed_{low}}\right)$$

Given that:

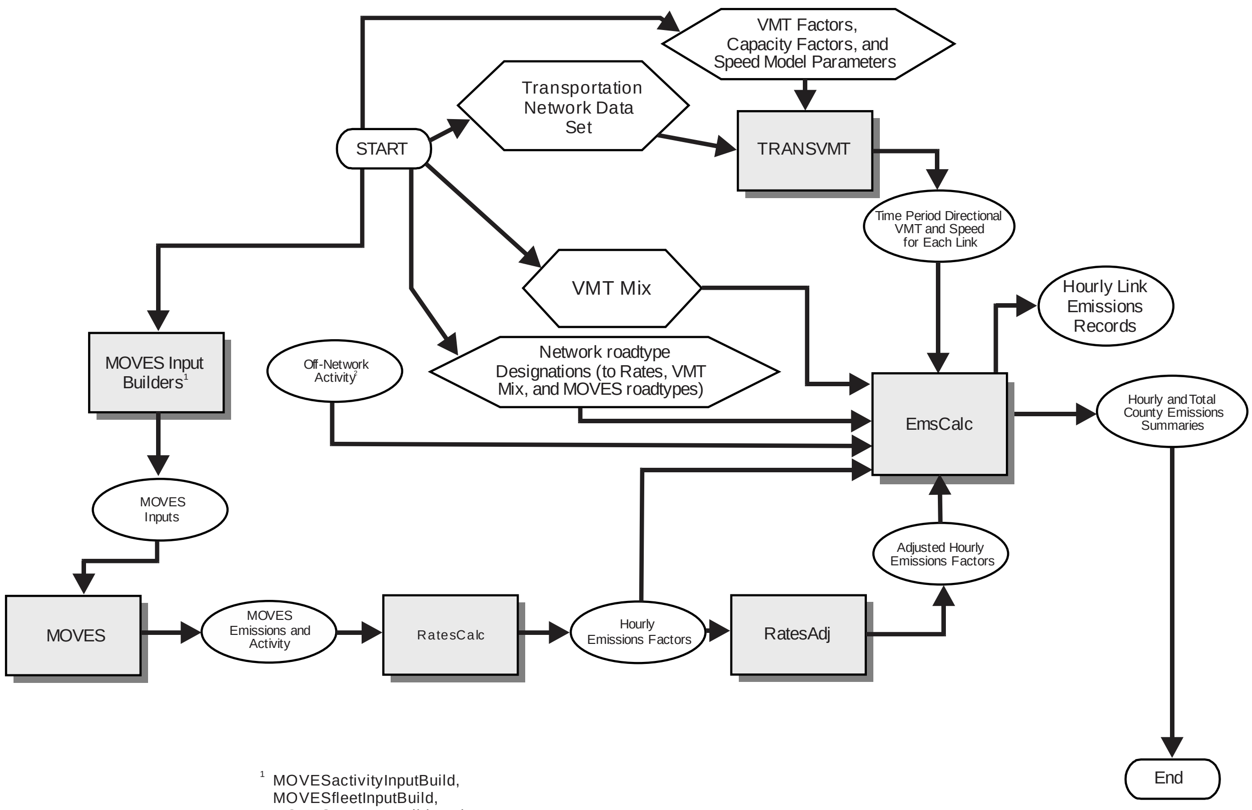
$EF_{LowSpeed}$ = 0.7413 g/mi;
$EF_{HighSpeed}$ = 0.7274 g/mi;
$Speed_{lnk}$ = 41.2 mph;
$Speed_{low}$ = 40 mph; and
$Speed_{high}$ = 45 mph.

$$FAC_{Interp} = \left(\frac{1}{41.2mph} - \frac{1}{40mph}\right) \Big/ \left(\frac{1}{45mph} - \frac{1}{40mph}\right) = \frac{-0.00073}{-0.00278} = 0.26214;$$

EF_{Interp} = 0.7413 g/mi - (0.26214) × (0.7413 g/mi - 0.7274 g/mi);

= 0.7377 g/mi.

Travel Demand Model Network Link-Based Hourly MOVES Emissions Estimates



[1] MOVESactivityInputBuild, MOVESfleetInputBuild, MOVESmetInputBuild, and VehPopulationBuild.

[2] VehPopulationBuild, and OffNetActCalc.

APPENDIX C:
TXDOT DISTRICT WEEKDAY VMT MIXES BY MOVES ROAD TYPE CATEGORY

VMT Mix Year/Analysis Year Correlations

VMT Mix Year	Analysis Years
2000	1998 through 2002
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032
2035	2033 through 2037
2040	2038 +

2015 Weekday VMT Mix – San Antonio TxDOT District

SUT/FT	AM Peak				Mid-Day				PM Peak				Overnight			
	RT2[1]	RT3[2]	RT4[3]	RT5[4]	RT2[1]	RT3[2]	RT4[3]	RT5[4]	RT2[1]	RT3[2]	RT4[3]	RT5[4]	RT2[1]	RT3[2]	RT4[3]	RT5[4]
21_D	0.00413	0.00435	0.00508	0.00527	0.00402	0.00411	0.00481	0.00522	0.00435	0.00449	0.00519	0.00547	0.00338	0.00384	0.00486	0.00537
21_G	0.58604	0.61641	0.72063	0.74736	0.56979	0.58314	0.68255	0.74045	0.61750	0.63729	0.73655	0.77613	0.47920	0.54534	0.68953	0.76124
31_D	0.00311	0.00367	0.00275	0.00261	0.00289	0.00383	0.00294	0.00258	0.00288	0.00372	0.00272	0.00257	0.00277	0.00416	0.00275	0.00264
31_G	0.17954	0.21199	0.15880	0.15084	0.16727	0.22168	0.17011	0.14947	0.16658	0.21538	0.15713	0.14859	0.15994	0.24044	0.15881	0.15241
32_D	0.00247	0.00291	0.00218	0.00207	0.00230	0.00304	0.00234	0.00205	0.00229	0.00296	0.00216	0.00204	0.00220	0.00330	0.00218	0.00209
32_G	0.04406	0.05202	0.03897	0.03701	0.04104	0.05440	0.04174	0.03668	0.04088	0.05285	0.03856	0.03646	0.03925	0.05900	0.03897	0.03740
51_D	0.00165	0.00181	0.00106	0.00100	0.00173	0.00199	0.00130	0.00112	0.00111	0.00140	0.00069	0.00054	0.00123	0.00155	0.00082	0.00057
51_G	0.00065	0.00071	0.00042	0.00039	0.00068	0.00079	0.00051	0.00044	0.00044	0.00055	0.00027	0.00021	0.00048	0.00061	0.00032	0.00022
52_D	0.03296	0.03606	0.02108	0.01990	0.03454	0.03984	0.02604	0.02229	0.02221	0.02791	0.01374	0.01086	0.02454	0.03093	0.01644	0.01136
52_G	0.01301	0.01423	0.00832	0.00785	0.01363	0.01572	0.01028	0.00880	0.00877	0.01101	0.00542	0.00429	0.00969	0.01221	0.00649	0.00449
53_D	0.00338	0.00370	0.00216	0.00204	0.00354	0.00408	0.00267	0.00229	0.00228	0.00286	0.00141	0.00111	0.00252	0.00317	0.00169	0.00117
53_G	0.00133	0.00146	0.00085	0.00081	0.00140	0.00161	0.00105	0.00090	0.00090	0.00113	0.00056	0.00044	0.00099	0.00125	0.00067	0.00046
54_D	0.00130	0.00142	0.00083	0.00078	0.00136	0.00157	0.00102	0.00088	0.00087	0.00110	0.00054	0.00043	0.00097	0.00122	0.00065	0.00045
54_G	0.00051	0.00056	0.00033	0.00031	0.00054	0.00062	0.00040	0.00035	0.00034	0.00043	0.00021	0.00017	0.00038	0.00048	0.00026	0.00018
41_D	0.00028	0.00052	0.00037	0.00072	0.00039	0.00039	0.00033	0.00057	0.00026	0.00023	0.00017	0.00024	0.00056	0.00035	0.00028	0.00046
42_D	0.00056	0.00104	0.00073	0.00144	0.00077	0.00078	0.00066	0.00114	0.00051	0.00046	0.00033	0.00048	0.00111	0.00070	0.00057	0.00091
42_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43_D	0.00153	0.00286	0.00201	0.00396	0.00212	0.00214	0.00180	0.00312	0.00140	0.00127	0.00091	0.00132	0.00305	0.00193	0.00156	0.00251
43_G	0.00002	0.00003	0.00002	0.00004	0.00002	0.00002	0.00002	0.00003	0.00001	0.00001	0.00001	0.00001	0.00003	0.00002	0.00002	0.00003
61_D	0.05138	0.01825	0.01367	0.00621	0.06330	0.02494	0.02037	0.00874	0.05259	0.01434	0.01368	0.00329	0.11174	0.03719	0.03029	0.00639
61_G	0.00539	0.00192	0.00144	0.00065	0.00665	0.00262	0.00214	0.00092	0.00552	0.00151	0.00144	0.00034	0.01173	0.00390	0.00318	0.00067
62_D	0.06611	0.02348	0.01759	0.00799	0.08146	0.03210	0.02621	0.01125	0.06768	0.01845	0.01760	0.00423	0.14378	0.04785	0.03898	0.00822
62_G	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11_G	0.00059	0.00062	0.00073	0.00075	0.00057	0.00059	0.00069	0.00075	0.00062	0.00064	0.00074	0.00078	0.00048	0.00055	0.00070	0.00077

[1] RT2 - Rural Restricted Access; [2] RT3 – rural Unrestricted Access; [3] RT4 - Urban Restricted Access; [4] RT5 – Urban Unrestricted Access.

APPENDIX D:
TXDOT DISTIRCT AGGREGATE WEEKDAY VMT MIX

VMT Mix Year/Analysis Year Correlations

VMT Mix Year	Analysis Years
2000	1998 through 2002
2005	2003 through 2007
2010	2008 through 2012
2015	2013 through 2017
2020	2018 through 2022
2025	2023 through 2027
2030	2028 through 2032
2035	2033 through 2037
2040	2038 +

Aggregate Weekday VMT Mix – San Antonio TxDOT District

SUT/FT	2015
21_D	0.00471
21_G	0.66803
31_D	0.00293
31_G	0.16953
32_D	0.00233
32_G	0.04160
51_D	0.00118
51_G	0.00046
52_D	0.02352
52_G	0.00928
53_D	0.00241
53_G	0.00095
54_D	0.00093
54_G	0.00037
41_D	0.00033
42_D	0.00067
42_G	0.00000
43_D	0.00184
43_G	0.00002
61_D	0.02853
61_G	0.00300
62_D	0.03672
62_G	0.00000
11_G	0.00067

APPENDIX E:
DIRECTIONAL SPLIT ESTIMATES

San Antonio TDM AM Peak Directional Split Factors

Functional Class Code	Area Type Code				
	1	2	3	4	5
0	50.0	50.0	50.0	50.0	50.0
1	53.4	74.1	53.4	61.3	61.7
3	53.4	74.1	53.4	61.3	61.7
5	53.4	74.1	53.4	61.3	61.7
7	53.4	74.1	53.4	61.3	61.7
9	53.4	74.1	53.4	61.3	61.7
10	53.4	74.1	53.4	61.3	61.7
11	68.7	68.0	68.7	56.4	61.7
12	68.7	68.0	68.7	56.4	61.7
13	68.7	68.0	68.7	56.4	61.7
14	68.7	68.0	68.7	56.4	61.7
15	68.7	68.0	68.7	56.4	61.7
16	68.7	68.0	68.7	56.4	61.7
17	65.9	65.9	65.9	65.9	65.6
18	65.9	65.9	65.9	65.9	65.6
19	65.9	65.9	65.9	65.9	65.6
20	68.7	68.0	68.7	56.4	61.7
21	68.7	68.0	68.7	56.4	61.7
22	53.4	74.1	53.4	61.3	61.7

San Antonio TDM Mid-Day Peak Directional Split Factors

Functional Class Code	Area Type Code				
	1	2	3	4	5
0	50.0	50.0	50.0	50.0	50.0
1	51.9	58.9	51.9	54.2	56.2
3	51.9	58.9	51.9	54.2	56.2
5	51.9	58.9	51.9	54.2	56.2
7	51.9	58.9	51.9	54.2	56.2
9	51.9	58.9	51.9	54.2	56.2
10	51.9	58.9	51.9	54.2	56.2
11	59.8	57.9	59.8	54.0	56.2
12	59.8	57.9	59.8	54.0	56.2
13	59.8	57.9	59.8	54.0	56.2
14	59.8	57.9	59.8	54.0	56.2
15	59.8	57.9	59.8	54.0	56.2
16	59.8	57.9	59.8	54.0	56.2
17	59.5	59.5	59.5	59.5	58.3
18	59.5	59.5	59.5	59.5	58.3
19	59.5	59.5	59.5	59.5	58.3
20	59.8	57.9	59.8	54.0	56.2
21	59.8	57.9	59.8	54.0	56.2
22	51.9	58.9	51.9	54.2	56.2

San Antonio TDM PM Peak Directional Split Factors

Functional Class Code	Area Type Code				
	1	2	3	4	5
0	50.0	50.0	50.0	50.0	50.0
1	52.6	69.4	52.6	56.5	58.0
3	52.6	69.4	52.6	56.5	58.0
5	52.6	69.4	52.6	56.5	58.0
7	52.6	69.4	52.6	56.5	58.0
9	52.6	69.4	52.6	56.5	58.0
10	52.6	69.4	52.6	56.5	58.0
11	63.8	60.3	63.8	56.8	58.0
12	63.8	60.3	63.8	56.8	58.0
13	63.8	60.3	63.8	56.8	58.0
14	63.8	60.3	63.8	56.8	58.0
15	63.8	60.3	63.8	56.8	58.0
16	63.8	60.3	63.8	56.8	58.0
17	60.1	60.1	60.1	60.1	57.4
18	60.1	60.1	60.1	60.1	57.4
19	60.1	60.1	60.1	60.1	57.4
20	63.8	60.3	63.8	56.8	58.0
21	63.8	60.3	63.8	56.8	58.0
22	52.6	69.4	52.6	56.5	58.0

San Antonio TDM Overnight Directional Split Factors

Functional Class Code	Area Type Code				
	1	2	3	4	5
0	50.0	50.0	50.0	50.0	50.0
1	52.9	57.8	52.9	58.4	60.9
3	52.9	57.8	52.9	58.4	60.9
5	52.9	57.8	52.9	58.4	60.9
7	52.9	57.8	52.9	58.4	60.9
9	52.9	57.8	52.9	58.4	60.9
10	52.9	57.8	52.9	58.4	60.9
11	64.1	60.1	64.1	58.9	60.9
12	64.1	60.1	64.1	58.9	60.9
13	64.1	60.1	64.1	58.9	60.9
14	64.1	60.1	64.1	58.9	60.9
15	64.1	60.1	64.1	58.9	60.9
16	64.1	60.1	64.1	58.9	60.9
17	63.1	63.1	63.1	63.1	60.5
18	63.1	63.1	63.1	63.1	60.5
19	63.1	63.1	63.1	63.1	60.5
20	64.1	60.1	64.1	58.9	60.9
21	64.1	60.1	64.1	58.9	60.9
22	52.9	57.8	52.9	58.4	60.9

San Antonio TDM Area Type Codes and Descriptions

Area Type Code	Area Type Description
1	CBD
2	CBD Fringe
3	Urban
4	Suburban
5	Rural

San Antonio TDM Functional Class Codes and Descriptions

Functional Class Code	Functional Class Description
0	Centroid Connector
1	Radial IH Freeways - Mainlanes Only
3	Circumferential IH Freeways (Loops) - Mainlanes Only
5	Radial Other Freeways - Mainlanes Only
7	Circumferential Other Freeways (Loops) - Mainlanes Only
9	Radial Expressways
10	Circumferential Expressways
11	Principal Arterial – Divided
12	Principal Arterial - Continuous Left Turn Lane
13	Principal Arterial – Undivided
14	Minor Arterial – Divided
15	Minor Arterial - Continuous Left Turn Lane
16	Minor Arterial – Undivided
17	Collector – Divided
18	Collector - Continuous Left Turn Lane
19	Collector - Undivided
20	Frontage Road
21	Ramp (Between Frontage Road and Mainlanes)
22	Interchange Ramp (Freeway-to-Freeway Interchange Ramps)

APPENDIX F:
CAPACITY FACTORS AND SPEED FACTORS

San Antonio TDM Hourly Capacity Factors

Functional Class Code	Area Type Code				
	1	2	3	4	5
0	0.100000	0.100000	0.100000	0.100000	0.100000
1	0.075251	0.072663	0.074464	0.080980	0.138696
3	0.075251	0.072663	0.074464	0.080980	0.138696
5	0.093750	0.097884	0.098684	0.112069	0.126582
7	0.093750	0.093909	0.093284	0.103175	0.111732
9	0.091837	0.096354	0.101957	0.120370	0.136986
10	0.078261	0.074000	0.070262	0.079918	0.112360
11	0.061111	0.063158	0.065000	0.078378	0.123077
12	0.061111	0.063158	0.065000	0.078378	0.123077
13	0.062500	0.062857	0.066667	0.081818	0.126087
14	0.110000	0.109091	0.104167	0.127273	0.187500
15	0.110000	0.109091	0.104167	0.127273	0.187500
16	0.105263	0.110000	0.104545	0.125000	0.192857
17	0.084211	0.080952	0.078261	0.100000	0.210000
18	0.084211	0.080952	0.078261	0.100000	0.210000
19	0.077778	0.078947	0.076190	0.100000	0.237500
20	0.110000	0.109091	0.104167	0.127273	0.181250
21	0.073333	0.080000	0.083333	0.093333	0.100000
22	0.073333	0.080000	0.083333	0.093333	0.100000

San Antonio TDM Free-Flow Speed Factors

Functional Class Code	Area Type Code				
	1	2	3	4	5
0	1.000000	1.000000	1.000000	1.000000	1.000000
1	1.486490	1.380950	1.304350	1.326530	1.320750
3	1.375000	1.380950	1.304350	1.326530	1.296300
5	1.441300	1.398260	1.278230	1.292250	1.325760
7	1.528200	1.451450	1.346500	1.369000	1.412710
9	1.573430	1.522840	1.321700	1.281750	1.283420
10	1.607140	1.500000	1.388890	1.375000	1.176470
11	1.739130	1.535710	1.406250	1.351350	1.100000
12	1.739130	1.592590	1.451610	1.388890	1.122450
13	1.727270	1.538460	1.551720	1.470590	1.170210
14	1.666670	1.520000	1.379310	1.323530	1.041670
15	1.666670	1.520000	1.379310	1.323530	1.086960
16	1.650000	1.458330	1.428570	1.363640	1.111110
17	1.666670	1.500000	1.346150	1.333330	1.022730
18	1.764710	1.571430	1.400000	1.379310	1.046510
19	1.647060	1.500000	1.458330	1.428570	1.071430
20	1.904760	1.720000	1.551720	1.470590	1.222220
21	1.346150	1.333330	1.323530	1.282050	1.100000
22	1.250000	1.250000	1.250000	1.219510	1.057690

San Antonio TDM Area Type Codes and Descriptions

Area Type Code	Area Type Description
1	CBD
2	CBD Fringe
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4	Suburban
5	Rural

San Antonio TDM Functional Class Codes and Descriptions

Functional Class Code	Functional Class Description
0	Centroid Connector
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3	Circumferential IH Freeways (Loops) - Mainlanes Only
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7	Circumferential Other Freeways (Loops) - Mainlanes Only
9	Radial Expressways
10	Circumferential Expressways
11	Principal Arterial – Divided
12	Principal Arterial - Continuous Left Turn Lane
13	Principal Arterial – Undivided
14	Minor Arterial – Divided
15	Minor Arterial - Continuous Left Turn Lane
16	Minor Arterial – Undivided
17	Collector – Divided
18	Collector - Continuous Left Turn Lane
19	Collector - Undivided
20	Frontage Road
21	Ramp (Between Frontage Road and Mainlanes)
22	Interchange Ramp (Freeway-to-Freeway Interchange Ramps)

APPENDIX G:
VEHICLE POPULATION ESTIMATES AND 24-HOUR SHP, STARTS, HOTELLING HOURS, SHI, AND APU HOURS SUMMARIES

2014 Vehicle Population Estimates

SUT/FT	Bexar	Comal	Guadalupe	Kendall	Wilson
21_D	6,282	460	459	176	127
21_G	890,914	65,229	65,072	24,902	18,010
31_D	4,084	429	405	157	192
31_G	236,301	24,797	23,438	9,072	11,137
32_D	3,248	341	322	125	153
32_G	57,985	6,085	5,751	2,226	2,733
51_D	573	106	81	51	57
51_G	223	41	31	20	22
52_D	11,426	2,114	1,609	1,011	1,140
52_G	4,508	834	635	399	450
53_D	1,171	217	165	104	117
53_G	462	85	65	41	46
54_D	452	84	64	40	45
54_G	180	33	25	16	18
41_D	160	30	23	14	16
42_D	325	60	46	29	32
42_G	0	0	0	0	0
43_D	894	165	126	79	89
43_G	10	2	1	1	1
61_D	5,484	947	417	140	124
61_G	577	100	44	15	13
62_D	7,059	1,219	537	181	160
62_G	0	0	0	0	0
11_G	24,584	3,774	3,310	1,149	1,026

24-Hour 2014 Weekday SHP Summaries

SUT/FT	Bexar	Comal	Guadalupe	Kendall	Wilson
21_D	145,037	10,550	10,617	4,116	2,918
21_G	20,570,477	1,496,220	1,505,779	583,822	413,857
31_D	94,982	9,976	9,465	3,689	4,505
31_G	5,495,770	577,198	547,666	213,440	260,657
32_D	75,536	7,933	7,527	2,934	3,583
32_G	1,348,575	141,635	134,389	52,375	63,961
51_D	12,695	2,425	1,833	1,184	1,322
51_G	4,947	945	714	462	515
52_D	253,016	48,331	36,529	23,603	26,342
52_G	99,825	19,069	14,412	9,313	10,393
53_D	25,923	4,952	3,743	2,418	2,699
53_G	10,218	1,952	1,475	953	1,064
54_D	10,008	1,911	1,445	933	1,042
54_G	3,983	761	575	371	415
41_D	3,379	673	508	332	372
42_D	6,876	1,368	1,032	674	756
42_G	0	0	0	0	0
43_D	18,885	3,756	2,833	1,850	2,077
43_G	207	41	31	20	23
61_D	116,989	21,064	7,995	2,599	2,284
61_G	12,304	2,215	841	273	240
62_D	150,578	27,111	10,291	3,346	2,940
62_G	0	0	0	0	0
11_G	589,197	90,506	79,384	27,562	24,605

24-Hour 2014 Weekday Starts Summaries

SUT/FT	Bexar	Comal	Guadalupe	Kendall	Wilson
21_D	33,780	2,473	2,467	944	683
21_G	4,790,975	350,775	349,932	133,915	96,851
31_D	22,775	2,390	2,259	874	1,073
31_G	1,317,788	138,286	130,710	50,590	62,106
32_D	19,541	2,051	1,938	750	921
32_G	348,883	36,611	34,605	13,394	16,443
51_D	2,206	408	311	195	220
51_G	860	159	121	76	86
52_D	81,615	15,098	11,495	7,221	8,143
52_G	32,202	5,957	4,535	2,849	3,213
53_D	5,207	963	733	461	520
53_G	2,052	380	289	182	205
54_D	258	48	36	23	26
54_G	103	19	14	9	10
41_D	462	85	65	41	46
42_D	1,548	286	218	137	154
42_G	0	0	0	0	0
43_D	5,258	973	741	465	525
43_G	57	11	8	5	6
61_D	33,286	5,750	2,532	851	752
61_G	3,500	605	266	90	79
62_D	30,260	5,227	2,302	774	684
62_G	0	0	0	0	0
11_G	11,137	1,710	1,500	521	465

24-Hour SHI and APU Hours Summaries (CLhT_Diesel Only)

County	2014		
	Hotelling	SHI	APU
Bexar	6,766	6,155	612
Comal	1,225	1,114	111
Guadalupe	367	334	33
Kendall	157	143	14
Wilson	29	27	3

APPENDIX H:
SOURCE TYPE AGE AND FUEL/ENGINE FRACTIONS INPUTS TO MOVES

Bexar County 2014 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.043809	0.083655	0.031649	0.031649	0.055550	0.055650	0.055556	0.064759	0.078367	0.080736	0.064928	0.063224	0.044007
1	0.072283	0.079679	0.044218	0.044218	0.049845	0.049946	0.049851	0.058272	0.087172	0.097975	0.058445	0.052919	0.048909
2	0.069110	0.075608	0.039487	0.039487	0.046006	0.046100	0.046012	0.053507	0.136024	0.150497	0.053673	0.055209	0.050486
3	0.047714	0.057317	0.040853	0.040853	0.042195	0.055697	0.032610	0.028999	0.097563	0.104892	0.039988	0.030149	0.032874
4	0.035755	0.054538	0.037965	0.037965	0.037253	0.034095	0.035647	0.022977	0.034129	0.036093	0.035305	0.015392	0.017742
5	0.085137	0.045184	0.027246	0.027246	0.031055	0.034678	0.042221	0.030317	0.030220	0.034013	0.029436	0.030149	0.031415
6	0.079442	0.065417	0.053449	0.053449	0.039993	0.048515	0.046183	0.023359	0.089955	0.093698	0.037928	0.045160	0.043640
7	0.099170	0.065704	0.059844	0.059844	0.052281	0.047012	0.047736	0.081433	0.057129	0.057695	0.049441	0.103931	0.094086
8	0.086520	0.060624	0.055232	0.055232	0.053396	0.033713	0.055776	0.060642	0.069104	0.064010	0.050348	0.078616	0.070679
9	0.065571	0.058521	0.054636	0.054636	0.055068	0.052558	0.049572	0.057049	0.064877	0.057569	0.051939	0.061951	0.061342
10	0.045802	0.051400	0.065779	0.065779	0.053504	0.043092	0.048835	0.034170	0.048570	0.040882	0.050306	0.043633	0.041119
11	0.053653	0.048621	0.068527	0.068527	0.049302	0.041983	0.041807	0.033378	0.035609	0.033007	0.046365	0.035110	0.032913
12	0.040473	0.045698	0.066863	0.066863	0.046065	0.042452	0.043802	0.024143	0.030466	0.026419	0.043333	0.030785	0.032437
13	0.030874	0.039989	0.061873	0.061873	0.044039	0.048613	0.039741	0.029530	0.028071	0.027473	0.041306	0.041471	0.043530
14	0.023918	0.036232	0.047958	0.047958	0.041778	0.032808	0.043136	0.040271	0.024760	0.021921	0.039197	0.061824	0.052520
15	0.019322	0.028007	0.042236	0.042236	0.040614	0.031806	0.039913	0.057676	0.021203	0.019697	0.037984	0.043760	0.044225
16	0.014359	0.021487	0.030333	0.030333	0.030599	0.037111	0.031314	0.052718	0.011200	0.009478	0.022205	0.033711	0.037120
17	0.011227	0.017094	0.030419	0.030419	0.024835	0.033826	0.029099	0.025424	0.012433	0.010221	0.034115	0.018573	0.028101
18	0.008257	0.012110	0.020619	0.020619	0.020413	0.030975	0.024947	0.032795	0.006375	0.005665	0.020938	0.019209	0.025898
19	0.007688	0.011328	0.020954	0.020954	0.026465	0.025322	0.031789	0.041994	0.006939	0.006044	0.024651	0.027986	0.032080
20	0.005776	0.008096	0.019783	0.019783	0.020257	0.021951	0.015251	0.029313	0.004438	0.003876	0.023297	0.015647	0.020867
21	0.005491	0.006015	0.013312	0.013312	0.016634	0.018163	0.018167	0.013318	0.003945	0.002748	0.015998	0.015901	0.017990
22	0.004230	0.004539	0.009621	0.009621	0.012252	0.015769	0.014653	0.011855	0.002430	0.001875	0.013989	0.008396	0.012870
23	0.002481	0.003795	0.007970	0.007970	0.013802	0.015855	0.018594	0.018450	0.002501	0.002168	0.010346	0.010050	0.014209
24	0.002603	0.002793	0.006276	0.006276	0.015451	0.023149	0.020950	0.013061	0.002642	0.001735	0.013522	0.009795	0.012572
25	0.002237	0.002186	0.005994	0.005994	0.015325	0.017611	0.011953	0.020123	0.002008	0.001442	0.017413	0.008905	0.009605
26	0.002237	0.001615	0.004496	0.004496	0.014173	0.013781	0.014128	0.011515	0.001585	0.001180	0.015355	0.005597	0.007859
27	0.001830	0.001394	0.003107	0.003107	0.014696	0.012718	0.014276	0.010304	0.001479	0.000678	0.014965	0.005216	0.006202
28	0.003498	0.001124	0.003776	0.003776	0.012327	0.010714	0.012460	0.005268	0.001303	0.000875	0.010998	0.006361	0.006083
29	0.002807	0.001121	0.003554	0.003554	0.010702	0.009139	0.010634	0.005263	0.001479	0.000762	0.011609	0.004452	0.005596
30	0.026725	0.009107	0.021968	0.021968	0.014149	0.015191	0.013386	0.008114	0.006023	0.004677	0.020675	0.016919	0.021026

Comal County 2014 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.039746	0.052307	0.027108	0.027108	0.055550	0.055650	0.055556	0.064759	0.078367	0.080736	0.064928	0.063224	0.044007
1	0.063858	0.083119	0.049130	0.049130	0.049845	0.049946	0.049851	0.058272	0.087172	0.097975	0.058445	0.052919	0.048909
2	0.052464	0.080135	0.046002	0.046002	0.046006	0.046100	0.046012	0.053507	0.136024	0.150497	0.053673	0.055209	0.050486
3	0.042660	0.065764	0.045180	0.045180	0.042195	0.055697	0.032610	0.028999	0.097563	0.104892	0.039988	0.030149	0.032874
4	0.041070	0.059599	0.041610	0.041610	0.037253	0.034095	0.035647	0.022977	0.034129	0.036093	0.035305	0.015392	0.017742
5	0.071277	0.049841	0.032795	0.032795	0.031055	0.034678	0.042221	0.030317	0.030220	0.034013	0.029436	0.030149	0.031415
6	0.077636	0.073224	0.058039	0.058039	0.039993	0.048515	0.046183	0.023359	0.089955	0.093698	0.037928	0.045160	0.043640
7	0.099894	0.071016	0.062273	0.062273	0.052281	0.047012	0.047736	0.081433	0.057129	0.057695	0.049441	0.103931	0.094086
8	0.074192	0.064699	0.062620	0.062620	0.053396	0.033713	0.055776	0.060642	0.069104	0.064010	0.050348	0.078616	0.070679
9	0.060943	0.058868	0.057850	0.057850	0.055068	0.052558	0.049572	0.057049	0.064877	0.057569	0.051939	0.061951	0.061342
10	0.050079	0.051333	0.066886	0.066886	0.053504	0.043092	0.048835	0.034170	0.048570	0.040882	0.050306	0.043633	0.041119
11	0.065448	0.046172	0.066412	0.066412	0.049302	0.041983	0.041807	0.033378	0.035609	0.033007	0.046365	0.035110	0.032913
12	0.047960	0.041818	0.062241	0.062241	0.046065	0.042452	0.043802	0.024143	0.030466	0.026419	0.043333	0.030785	0.032437
13	0.034711	0.035105	0.058482	0.058482	0.044039	0.048613	0.039741	0.029530	0.028071	0.027473	0.041306	0.041471	0.043530
14	0.030207	0.033111	0.044517	0.044517	0.041778	0.032808	0.043136	0.040271	0.024760	0.021921	0.039197	0.061824	0.052520
15	0.023317	0.026960	0.040157	0.040157	0.040614	0.031806	0.039913	0.057676	0.021203	0.019697	0.037984	0.043760	0.044225
16	0.014308	0.020445	0.026381	0.026381	0.030599	0.037111	0.031314	0.052718	0.011200	0.009478	0.022205	0.033711	0.037120
17	0.014308	0.015604	0.029035	0.029035	0.024835	0.033826	0.029099	0.025424	0.012433	0.010221	0.034115	0.018573	0.028101
18	0.009804	0.012194	0.020347	0.020347	0.020413	0.030975	0.024947	0.032795	0.006375	0.005665	0.020938	0.019209	0.025898
19	0.011924	0.010413	0.016998	0.016998	0.026465	0.025322	0.031789	0.041994	0.006939	0.006044	0.024651	0.027986	0.032080
20	0.007684	0.007459	0.016113	0.016113	0.020257	0.021951	0.015251	0.029313	0.004438	0.003876	0.023297	0.015647	0.020867
21	0.006889	0.005952	0.012227	0.012227	0.016634	0.018163	0.018167	0.013318	0.003945	0.002748	0.015998	0.015901	0.017990
22	0.006359	0.004186	0.008815	0.008815	0.012252	0.015769	0.014653	0.011855	0.002430	0.001875	0.013989	0.008396	0.012870
23	0.002385	0.003988	0.006319	0.006319	0.013802	0.015855	0.018594	0.018450	0.002501	0.002168	0.010346	0.010050	0.014209
24	0.002120	0.003151	0.005813	0.005813	0.015451	0.023149	0.020950	0.013061	0.002642	0.001735	0.013522	0.009795	0.012572
25	0.003975	0.002375	0.004834	0.004834	0.015325	0.017611	0.011953	0.020123	0.002008	0.001442	0.017413	0.008905	0.009605
26	0.002120	0.001888	0.002780	0.002780	0.014173	0.013781	0.014128	0.011515	0.001585	0.001180	0.015355	0.005597	0.007859
27	0.003445	0.001857	0.002148	0.002148	0.014696	0.012718	0.014276	0.010304	0.001479	0.000678	0.014965	0.005216	0.006202
28	0.002650	0.001340	0.003633	0.003633	0.012327	0.010714	0.012460	0.005268	0.001303	0.000875	0.010998	0.006361	0.006083
29	0.005299	0.001431	0.002970	0.002970	0.010702	0.009139	0.010634	0.005263	0.001479	0.000762	0.011609	0.004452	0.005596
30	0.031267	0.014645	0.020284	0.020284	0.014149	0.015191	0.013386	0.008114	0.006023	0.004677	0.020675	0.016919	0.021026

Guadalupe County 2014 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.037764	0.047443	0.028512	0.028512	0.055550	0.055650	0.055556	0.064759	0.078367	0.080736	0.064928	0.063224	0.044007
1	0.057402	0.078604	0.045793	0.045793	0.049845	0.049946	0.049851	0.058272	0.087172	0.097975	0.058445	0.052919	0.048909
2	0.067976	0.079230	0.041481	0.041481	0.046006	0.046100	0.046012	0.053507	0.136024	0.150497	0.053673	0.055209	0.050486
3	0.046224	0.063329	0.042885	0.042885	0.042195	0.055697	0.032610	0.028999	0.097563	0.104892	0.039988	0.030149	0.032874
4	0.038066	0.059239	0.039910	0.039910	0.037253	0.034095	0.035647	0.022977	0.034129	0.036093	0.035305	0.015392	0.017742
5	0.095468	0.050587	0.032390	0.032390	0.031055	0.034678	0.042221	0.030317	0.030220	0.034013	0.029436	0.030149	0.031415
6	0.076737	0.072317	0.053916	0.053916	0.039993	0.048515	0.046183	0.023359	0.089955	0.093698	0.037928	0.045160	0.043640
7	0.096073	0.070989	0.059565	0.059565	0.052281	0.047012	0.047736	0.081433	0.057129	0.057695	0.049441	0.103931	0.094086
8	0.086707	0.063802	0.056356	0.056356	0.053396	0.033713	0.055776	0.060642	0.069104	0.064010	0.050348	0.078616	0.070679
9	0.064653	0.060445	0.053348	0.053348	0.055068	0.052558	0.049572	0.057049	0.064877	0.057569	0.051939	0.061951	0.061342
10	0.052568	0.053608	0.065682	0.065682	0.053504	0.043092	0.048835	0.034170	0.048570	0.040882	0.050306	0.043633	0.041119
11	0.061631	0.047489	0.063877	0.063877	0.049302	0.041983	0.041807	0.033378	0.035609	0.033007	0.046365	0.035110	0.032913
12	0.037160	0.044086	0.063476	0.063476	0.046065	0.042452	0.043802	0.024143	0.030466	0.026419	0.043333	0.030785	0.032437
13	0.031118	0.037890	0.061270	0.061270	0.044039	0.048613	0.039741	0.029530	0.028071	0.027473	0.041306	0.041471	0.043530
14	0.022961	0.034014	0.046596	0.046596	0.041778	0.032808	0.043136	0.040271	0.024760	0.021921	0.039197	0.061824	0.052520
15	0.022961	0.026903	0.041047	0.041047	0.040614	0.031806	0.039913	0.057676	0.021203	0.019697	0.037984	0.043760	0.044225
16	0.015710	0.021410	0.029883	0.029883	0.030599	0.037111	0.031314	0.052718	0.011200	0.009478	0.022205	0.033711	0.037120
17	0.011782	0.017183	0.027275	0.027275	0.024835	0.033826	0.029099	0.025424	0.012433	0.010221	0.034115	0.018573	0.028101
18	0.008761	0.012666	0.020423	0.020423	0.020413	0.030975	0.024947	0.032795	0.006375	0.005665	0.020938	0.019209	0.025898
19	0.006042	0.011659	0.021660	0.021660	0.026465	0.025322	0.031789	0.041994	0.006939	0.006044	0.024651	0.027986	0.032080
20	0.006647	0.007920	0.020189	0.020189	0.020257	0.021951	0.015251	0.029313	0.004438	0.003876	0.023297	0.015647	0.020867
21	0.004230	0.006775	0.014139	0.014139	0.016634	0.018163	0.018167	0.013318	0.003945	0.002748	0.015998	0.015901	0.017990
22	0.006344	0.005112	0.010429	0.010429	0.012252	0.015769	0.014653	0.011855	0.002430	0.001875	0.013989	0.008396	0.012870
23	0.002719	0.003983	0.007855	0.007855	0.013802	0.015855	0.018594	0.018450	0.002501	0.002168	0.010346	0.010050	0.014209
24	0.003323	0.003372	0.006017	0.006017	0.015451	0.023149	0.020950	0.013061	0.002642	0.001735	0.013522	0.009795	0.012572
25	0.002417	0.002503	0.006618	0.006618	0.015325	0.017611	0.011953	0.020123	0.002008	0.001442	0.017413	0.008905	0.009605
26	0.001511	0.001862	0.004312	0.004312	0.014173	0.013781	0.014128	0.011515	0.001585	0.001180	0.015355	0.005597	0.007859
27	0.002115	0.001480	0.002908	0.002908	0.014696	0.012718	0.014276	0.010304	0.001479	0.000678	0.014965	0.005216	0.006202
28	0.003625	0.001221	0.004914	0.004914	0.012327	0.010714	0.012460	0.005268	0.001303	0.000875	0.010998	0.006361	0.006083
29	0.002115	0.001389	0.004145	0.004145	0.010702	0.009139	0.010634	0.005263	0.001479	0.000762	0.011609	0.004452	0.005596
30	0.027190	0.011491	0.023131	0.023131	0.014149	0.015191	0.013386	0.008114	0.006023	0.004677	0.020675	0.016919	0.021026

Kendall County 2014 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.046997	0.054271	0.029709	0.029709	0.055550	0.055650	0.055556	0.064759	0.078367	0.080736	0.064928	0.063224	0.044007
1	0.084421	0.089680	0.051559	0.051559	0.049845	0.049946	0.049851	0.058272	0.087172	0.097975	0.058445	0.052919	0.048909
2	0.067885	0.081825	0.050695	0.050695	0.046006	0.046100	0.046012	0.053507	0.136024	0.150497	0.053673	0.055209	0.050486
3	0.037424	0.072932	0.048795	0.048795	0.042195	0.055697	0.032610	0.028999	0.097563	0.104892	0.039988	0.030149	0.032874
4	0.037424	0.063402	0.044218	0.044218	0.037253	0.034095	0.035647	0.022977	0.034129	0.036093	0.035305	0.015392	0.017742
5	0.087903	0.051998	0.030918	0.030918	0.031055	0.034678	0.042221	0.030317	0.030220	0.034013	0.029436	0.030149	0.031415
6	0.064404	0.077678	0.061404	0.061404	0.039993	0.048515	0.046183	0.023359	0.089955	0.093698	0.037928	0.045160	0.043640
7	0.075718	0.073172	0.062095	0.062095	0.052281	0.047012	0.047736	0.081433	0.057129	0.057695	0.049441	0.103931	0.094086
8	0.087903	0.061408	0.063995	0.063995	0.053396	0.033713	0.055776	0.060642	0.069104	0.064010	0.050348	0.078616	0.070679
9	0.060052	0.055108	0.055963	0.055963	0.055068	0.052558	0.049572	0.057049	0.064877	0.057569	0.051939	0.061951	0.061342
10	0.046127	0.052078	0.071768	0.071768	0.053504	0.043092	0.048835	0.034170	0.048570	0.040882	0.050306	0.043633	0.041119
11	0.054830	0.044501	0.063909	0.063909	0.049302	0.041983	0.041807	0.033378	0.035609	0.033007	0.046365	0.035110	0.032913
12	0.039164	0.040035	0.057950	0.057950	0.046065	0.042452	0.043802	0.024143	0.030466	0.026419	0.043333	0.030785	0.032437
13	0.028721	0.034373	0.053459	0.053459	0.044039	0.048613	0.039741	0.029530	0.028071	0.027473	0.041306	0.041471	0.043530
14	0.031332	0.028551	0.040763	0.040763	0.041778	0.032808	0.043136	0.040271	0.024760	0.021921	0.039197	0.061824	0.052520
15	0.026980	0.022171	0.035927	0.035927	0.040614	0.031806	0.039913	0.057676	0.021203	0.019697	0.037984	0.043760	0.044225
16	0.013055	0.017665	0.025736	0.025736	0.030599	0.037111	0.031314	0.052718	0.011200	0.009478	0.022205	0.033711	0.037120
17	0.011314	0.014196	0.028154	0.028154	0.024835	0.033826	0.029099	0.025424	0.012433	0.010221	0.034115	0.018573	0.028101
18	0.014795	0.009690	0.019432	0.019432	0.020413	0.030975	0.024947	0.032795	0.006375	0.005665	0.020938	0.019209	0.025898
19	0.007833	0.009770	0.020036	0.020036	0.026465	0.025322	0.031789	0.041994	0.006939	0.006044	0.024651	0.027986	0.032080
20	0.006963	0.005662	0.013991	0.013991	0.020257	0.021951	0.015251	0.029313	0.004438	0.003876	0.023297	0.015647	0.020867
21	0.006092	0.004984	0.011314	0.011314	0.016634	0.018163	0.018167	0.013318	0.003945	0.002748	0.015998	0.015901	0.017990
22	0.003481	0.003708	0.008636	0.008636	0.012252	0.015769	0.014653	0.011855	0.002430	0.001875	0.013989	0.008396	0.012870
23	0.006963	0.003988	0.007341	0.007341	0.013802	0.015855	0.018594	0.018450	0.002501	0.002168	0.010346	0.010050	0.014209
24	0.004352	0.003150	0.005095	0.005095	0.015451	0.023149	0.020950	0.013061	0.002642	0.001735	0.013522	0.009795	0.012572
25	0.005222	0.002592	0.006736	0.006736	0.015325	0.017611	0.011953	0.020123	0.002008	0.001442	0.017413	0.008905	0.009605
26	0.006092	0.001356	0.003714	0.003714	0.014173	0.013781	0.014128	0.011515	0.001585	0.001180	0.015355	0.005597	0.007859
27	0.002611	0.001595	0.002159	0.002159	0.014696	0.012718	0.014276	0.010304	0.001479	0.000678	0.014965	0.005216	0.006202
28	0.000870	0.001356	0.003541	0.003541	0.012327	0.010714	0.012460	0.005268	0.001303	0.000875	0.010998	0.006361	0.006083
29	0.004352	0.001117	0.002418	0.002418	0.010702	0.009139	0.010634	0.005263	0.001479	0.000762	0.011609	0.004452	0.005596
30	0.028721	0.015990	0.018568	0.018568	0.014149	0.015191	0.013386	0.008114	0.006023	0.004677	0.020675	0.016919	0.021026

Wilson County 2014 Age Distribution Inputs to MOVES

Age	MC	PC	PT	LCT	IBus	Tbus	Sbus	RT	SUShT	SULhT	MH	CShT	CLhT
0	0.037037	0.051883	0.029828	0.029828	0.055550	0.055650	0.055556	0.064759	0.078367	0.080736	0.064928	0.063224	0.044007
1	0.059454	0.085240	0.050791	0.050791	0.049845	0.049946	0.049851	0.058272	0.087172	0.097975	0.058445	0.052919	0.048909
2	0.049708	0.080112	0.045164	0.045164	0.046006	0.046100	0.046012	0.053507	0.136024	0.150497	0.053673	0.055209	0.050486
3	0.041910	0.061697	0.048470	0.048470	0.042195	0.055697	0.032610	0.028999	0.097563	0.104892	0.039988	0.030149	0.032874
4	0.038012	0.057727	0.038692	0.038692	0.037253	0.034095	0.035647	0.022977	0.034129	0.036093	0.035305	0.015392	0.017742
5	0.079922	0.049677	0.032642	0.032642	0.031055	0.034678	0.042221	0.030317	0.030220	0.034013	0.029436	0.030149	0.031415
6	0.076023	0.074158	0.056841	0.056841	0.039993	0.048515	0.046183	0.023359	0.089955	0.093698	0.037928	0.045160	0.043640
7	0.111111	0.068699	0.056912	0.056912	0.052281	0.047012	0.047736	0.081433	0.057129	0.057695	0.049441	0.103931	0.094086
8	0.091618	0.062028	0.058178	0.058178	0.053396	0.033713	0.055776	0.060642	0.069104	0.064010	0.050348	0.078616	0.070679
9	0.071150	0.059161	0.053746	0.053746	0.055068	0.052558	0.049572	0.057049	0.064877	0.057569	0.051939	0.061951	0.061342
10	0.032164	0.048961	0.060922	0.060922	0.053504	0.043092	0.048835	0.034170	0.048570	0.040882	0.050306	0.043633	0.041119
11	0.055556	0.044881	0.061695	0.061695	0.049302	0.041983	0.041807	0.033378	0.035609	0.033007	0.046365	0.035110	0.032913
12	0.043860	0.039643	0.060148	0.060148	0.046065	0.042452	0.043802	0.024143	0.030466	0.026419	0.043333	0.030785	0.032437
13	0.030214	0.036500	0.060077	0.060077	0.044039	0.048613	0.039741	0.029530	0.028071	0.027473	0.041306	0.041471	0.043530
14	0.022417	0.035066	0.047696	0.047696	0.041778	0.032808	0.043136	0.040271	0.024760	0.021921	0.039197	0.061824	0.052520
15	0.028265	0.025914	0.040661	0.040661	0.040614	0.031806	0.039913	0.057676	0.021203	0.019697	0.037984	0.043760	0.044225
16	0.014620	0.020125	0.029617	0.029617	0.030599	0.037111	0.031314	0.052718	0.011200	0.009478	0.022205	0.033711	0.037120
17	0.016569	0.018029	0.029617	0.029617	0.024835	0.033826	0.029099	0.025424	0.012433	0.010221	0.034115	0.018573	0.028101
18	0.007797	0.012075	0.020682	0.020682	0.020413	0.030975	0.024947	0.032795	0.006375	0.005665	0.020938	0.019209	0.025898
19	0.007797	0.012240	0.020823	0.020823	0.026465	0.025322	0.031789	0.041994	0.006939	0.006044	0.024651	0.027986	0.032080
20	0.006823	0.008877	0.020190	0.020190	0.020257	0.021951	0.015251	0.029313	0.004438	0.003876	0.023297	0.015647	0.020867
21	0.008772	0.007774	0.011889	0.011889	0.016634	0.018163	0.018167	0.013318	0.003945	0.002748	0.015998	0.015901	0.017990
22	0.005848	0.005403	0.008934	0.008934	0.012252	0.015769	0.014653	0.011855	0.002430	0.001875	0.013989	0.008396	0.012870
23	0.000975	0.005073	0.008794	0.008794	0.013802	0.015855	0.018594	0.018450	0.002501	0.002168	0.010346	0.010050	0.014209
24	0.003899	0.003970	0.006683	0.006683	0.015451	0.023149	0.020950	0.013061	0.002642	0.001735	0.013522	0.009795	0.012572
25	0.003899	0.003088	0.005487	0.005487	0.015325	0.017611	0.011953	0.020123	0.002008	0.001442	0.017413	0.008905	0.009605
26	0.001949	0.001819	0.005628	0.005628	0.014173	0.013781	0.014128	0.011515	0.001585	0.001180	0.015355	0.005597	0.007859
27	0.000975	0.001875	0.003658	0.003658	0.014696	0.012718	0.014276	0.010304	0.001479	0.000678	0.014965	0.005216	0.006202
28	0.005848	0.001489	0.003517	0.003517	0.012327	0.010714	0.012460	0.005268	0.001303	0.000875	0.010998	0.006361	0.006083
29	0.004873	0.001875	0.003517	0.003517	0.010702	0.009139	0.010634	0.005263	0.001479	0.000762	0.011609	0.004452	0.005596
30	0.040936	0.014942	0.018502	0.018502	0.014149	0.015191	0.013386	0.008114	0.006023	0.004677	0.020675	0.016919	0.021026

Texas Statewide 2014 Fuel Engine Fractions Summary

SUT	Fuel Type	Model Year															
		2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
PC	Gas	0.988	0.988	0.988	0.988	0.990	0.993	0.999	1.000	0.993	0.995	0.997	0.996	0.996	0.997	0.997	0.998
PC	Diesel	0.012	0.012	0.012	0.012	0.010	0.007	0.001	0.000	0.007	0.005	0.003	0.004	0.004	0.003	0.003	0.002
PT	Gas	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992	0.981
PT	Diesel	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008	0.019
PT	Gas	0.980	0.980	0.980	0.980	0.987	0.985	0.977	0.981	0.975	0.979	0.982	0.982	0.983	0.989	0.992	0.981
PT	Diesel	0.020	0.020	0.020	0.020	0.013	0.015	0.023	0.019	0.025	0.021	0.018	0.018	0.017	0.011	0.008	0.019
LCT	Gas	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949	0.929
LCT	Diesel	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051	0.071
LCT	Gas	0.947	0.947	0.947	0.947	0.962	0.955	0.941	0.948	0.938	0.946	0.951	0.951	0.956	0.908	0.949	0.929
LCT	Diesel	0.053	0.053	0.053	0.053	0.038	0.045	0.059	0.052	0.062	0.054	0.049	0.049	0.044	0.092	0.051	0.071
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
SBus	Diesel	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
RT	Gas	0.003	0.003	0.003	0.003	0.002	0.002	0.005	0.001	0.003	0.003	0.005	0.004	0.005	0.006	0.002	0.169
RT	Diesel	0.997	0.997	0.997	0.997	0.998	0.998	0.995	0.999	0.997	0.997	0.995	0.996	0.995	0.994	0.998	0.831
SUShT	Gas	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268	0.311	0.350	0.348
SUShT	Diesel	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732	0.689	0.650	0.652
SULhT	Gas	0.396	0.371	0.219	0.234	0.274	0.351	0.287	0.256	0.238	0.232	0.245	0.260	0.268	0.311	0.350	0.348
SULhT	Diesel	0.604	0.629	0.781	0.766	0.726	0.649	0.713	0.744	0.762	0.768	0.755	0.740	0.732	0.689	0.650	0.652
MH	Gas	0.500	0.500	0.500	0.500	0.500	0.500	0.510	0.530	0.540	0.560	0.570	0.590	0.600	0.630	0.660	0.680
MH	Diesel	0.500	0.500	0.500	0.500	0.500	0.500	0.490	0.470	0.460	0.440	0.430	0.410	0.400	0.370	0.340	0.320
CShT	Gas	0.094	0.199	0.110	0.057	0.081	0.052	0.058	0.031	0.050	0.051	0.052	0.055	0.077	0.084	0.090	0.107
CShT	Diesel	0.906	0.801	0.890	0.943	0.919	0.948	0.942	0.969	0.950	0.949	0.948	0.945	0.923	0.916	0.910	0.893
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Note: Conventional Internal Combustion engine technology only.

Texas Statewide 2014 Fuel Engine Fractions Summary - Continued

SUT	Fuel Type	Model Year														
		1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984
PC	Gas	0.998	0.999	0.999	0.999	1.000	0.999	0.999	0.997	0.999	0.999	1.000	0.987	0.991	0.966	0.956
PC	Diesel	0.002	0.001	0.001	0.001	0.000	0.001	0.001	0.003	0.001	0.001	0.000	0.013	0.009	0.034	0.044
PT	Gas	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996	0.986	0.984	0.979
PT	Diesel	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004	0.014	0.016	0.021
PT	Gas	0.993	0.992	0.981	0.995	0.991	0.986	0.985	0.994	0.989	0.992	0.997	0.996	0.986	0.984	0.979
PT	Diesel	0.007	0.008	0.019	0.005	0.009	0.014	0.015	0.006	0.011	0.008	0.003	0.004	0.014	0.016	0.021
LCT	Gas	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986	0.956	0.958	0.948
LCT	Diesel	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014	0.044	0.042	0.052
LCT	Gas	0.950	0.927	0.971	0.932	0.974	0.974	0.951	0.937	0.984	0.976	0.952	0.986	0.956	0.958	0.948
LCT	Diesel	0.050	0.073	0.029	0.068	0.026	0.026	0.049	0.063	0.016	0.024	0.048	0.014	0.044	0.042	0.052
IBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TBus	Gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TBus	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBus	Gas	0.010	0.010	0.042	0.114	0.147	0.121	0.010	0.090	0.124	0.229	0.250	0.265	0.327	0.484	0.615
SBus	Diesel	0.990	0.990	0.958	0.886	0.853	0.879	0.990	0.910	0.876	0.771	0.750	0.735	0.673	0.516	0.385
RT	Gas	0.404	0.019	0.012	0.010	0.105	0.031	0.210	0.101	0.204	0.029	0.106	0.106	0.062	0.051	0.054
RT	Diesel	0.596	0.981	0.988	0.990	0.895	0.969	0.790	0.899	0.796	0.971	0.894	0.894	0.938	0.949	0.946
SUShT	Gas	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654	0.742	0.731	0.920
SUShT	Diesel	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346	0.258	0.269	0.080
SULhT	Gas	0.435	0.436	0.427	0.673	0.508	0.519	0.511	0.465	0.539	0.572	0.640	0.654	0.742	0.731	0.920
SULhT	Diesel	0.565	0.564	0.573	0.327	0.492	0.481	0.489	0.535	0.461	0.428	0.360	0.346	0.258	0.269	0.080
MH	Gas	0.710	0.740	0.770	0.790	0.820	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
MH	Diesel	0.290	0.260	0.230	0.210	0.180	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
CShT	Gas	0.134	0.147	0.146	0.275	0.117	0.117	0.160	0.161	0.144	0.114	0.157	0.163	0.227	0.252	0.491
CShT	Diesel	0.866	0.853	0.854	0.725	0.883	0.883	0.840	0.839	0.856	0.886	0.843	0.837	0.773	0.748	0.509
CLhT	Diesel	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Note: Conventional Internal Combustion engine technology only.

APPENDIX I:
METEOROLOGICAL INPUTS TO MOVES

San Antonio Area Summer Season Temperature Inputs (Degrees Fahrenheit)[1]

Hour	Bexar	Comal	Guadalupe	Kendall	Wilson
1	79.2	77.0	76.7	77.8	79.2
2	78.1	76.1	75.6	76.9	78.2
3	77.2	75.4	75.0	75.6	77.5
4	76.6	75.1	74.6	74.9	76.8
5	76.1	74.7	74.2	74.5	76.2
6	75.6	74.3	73.8	73.7	75.6
7	75.3	74.0	73.5	73.3	75.3
8	75.7	75.2	74.9	73.4	75.6
9	77.6	77.9	77.9	75.6	77.9
10	80.0	80.7	80.9	78.2	80.6
11	82.5	84.1	84.2	80.2	83.4
12	85.2	87.1	87.1	83.5	86.0
13	87.5	89.7	89.6	85.8	88.3
14	89.4	91.4	91.3	87.1	90.4
15	91.2	92.9	92.6	89.3	92.1
16	92.3	93.8	93.6	90.4	93.1
17	92.9	94.0	93.8	90.8	93.7
18	93.1	93.3	93.0	90.9	93.3
19	92.1	91.6	91.4	89.9	92.0
20	90.1	88.3	88.2	88.7	90.0
21	87.1	84.4	84.3	85.0	87.0
22	84.6	82.1	81.8	82.7	84.4
23	82.7	80.3	80.1	81.4	82.2
24	80.8	78.5	78.2	79.1	80.5

[1] Average hourly - June through August, 2014.

San Antonio Area Summer Season Relative Humidity Inputs (Percent)[1]

Hour	Bexar	Comal	Guadalupe	Kendall	Wilson
1	75.1	79.4	81.3	71.6	75.5
2	77.3	82.0	84.6	73.8	78.4
3	80.6	84.2	86.6	78.3	81.3
4	82.7	85.7	88.0	80.2	83.5
5	84.1	87.0	89.1	81.1	85.1
6	85.7	87.9	90.2	83.4	86.4
7	86.4	88.7	90.9	84.4	87.6
8	85.6	87.6	89.9	84.9	86.2
9	80.0	81.3	83.1	79.9	80.8
10	73.0	73.2	74.3	72.6	73.5
11	65.9	63.3	64.4	67.8	65.5
12	57.9	55.6	56.4	57.9	57.9
13	52.1	49.8	50.6	51.9	52.2
14	48.8	45.9	46.6	49.7	47.8
15	43.8	42.6	43.7	43.7	43.6
16	41.6	40.8	41.9	41.7	41.7
17	41.1	40.2	41.0	41.1	40.9
18	41.0	41.2	42.0	40.9	40.8
19	43.0	44.4	45.1	42.5	42.9
20	47.5	50.4	51.3	44.1	48.9
21	55.3	58.4	59.2	52.1	55.2
22	60.6	64.3	65.6	57.6	60.3
23	64.8	69.6	70.7	60.1	66.0
24	70.6	74.8	76.4	67.3	70.7

[1] Average hourly - June through August, 2014.

San Antonio Area Summer Season Barometric Pressure (inches Mercury)1

Bexar	Comal	Guadalupe	Kendall	Wilson
29.93	29.95	29.94	29.92	29.92

[1] Average June through August, 2014.

San Antonio Area Winter Season Temperature Inputs (Degrees Fahrenheit)[1]

Hour	Bexar	Comal	Guadalupe	Kendall	Wilson
1	50.3	50.1	48.7	49.3	50.6
2	49.7	49.7	48.4	48.7	49.8
3	49.3	50.0	48.4	48.1	49.2
4	48.8	49.5	47.9	47.8	48.8
5	48.5	49.6	48.0	47.6	48.4
6	48.3	49.5	47.6	47.6	47.9
7	48.0	49.4	47.6	47.4	47.3
8	47.8	48.9	47.5	47.1	47.2
9	49.2	50.7	49.7	48.4	48.6
10	51.4	53.3	52.2	49.9	51.1
11	53.8	55.2	54.6	53.0	53.6
12	55.9	58.1	57.4	55.1	55.7
13	57.7	59.6	59.1	56.5	57.7
14	59.4	60.4	60.4	58.8	59.3
15	60.6	61.3	61.4	59.8	60.6
16	61.3	61.2	61.4	60.0	61.5
17	61.3	60.8	60.9	60.0	61.8
18	59.9	58.0	58.2	58.2	60.8
19	57.6	55.4	54.7	56.3	58.4
20	55.4	53.5	52.8	53.5	56.2
21	53.9	52.3	51.7	51.8	54.7
22	52.8	51.4	50.6	51.2	53.2
23	51.7	50.7	49.8	49.9	52.2
24	50.9	50.5	49.2	49.7	51.3

[1] Average hourly - December-January-February, 2014.

San Antonio Area Winter Season Relative Humidity Inputs (Percent)[1]

Hour	Bexar	Comal	Guadalupe	Kendall	Wilson
1	74.0	77.3	78.6	74.3	74.0
2	75.8	78.0	80.5	76.1	75.5
3	77.1	79.1	79.9	77.7	76.9
4	77.2	79.0	79.9	78.2	77.3
5	77.7	79.6	80.1	79.3	77.1
6	78.1	79.8	80.6	79.9	77.6
7	78.0	79.7	80.6	79.8	78.0
8	76.7	78.7	80.1	78.3	77.0
9	73.1	74.6	76.6	76.7	72.9
10	69.3	70.2	71.0	72.8	67.6
11	63.5	64.9	65.2	64.2	62.6
12	58.3	59.9	60.0	59.3	57.4
13	55.1	56.5	57.0	56.8	53.8
14	51.6	53.5	54.1	52.2	50.3
15	49.5	51.4	51.8	49.7	48.1
16	48.7	50.1	50.1	49.1	47.5
17	49.1	51.3	51.1	49.0	47.8
18	52.4	55.8	56.1	51.9	50.7
19	56.6	61.8	62.0	54.5	56.3
20	61.5	65.5	67.0	62.2	60.7
21	65.1	69.1	69.8	66.3	64.7
22	67.5	72.0	72.2	67.9	67.7
23	71.0	74.2	74.7	71.8	70.1
24	72.9	76.0	76.5	73.2	72.7

[1] Average hourly - December-January-February, 2014.

APPENDIX J:
SUMMARY OF MOVES RUNS

This appendix is being submitted electronically.

APPENDIX K:
ANNUAL ACTIVITY INPUTS

Day Type VMT Fractions by TxDOT District

Month	San Antonio	
	Week Day[1]	Weekend Day[2]
January	0.76151	0.23849
February	0.75980	0.24020
March	0.75518	0.24482
April	0.76344	0.23656
May	0.75765	0.24235
June	0.75718	0.24282
July	0.75447	0.24553
August	0.75886	0.24114
September	0.76222	0.23778
October	0.75991	0.24009
November	0.75743	0.24257
December	0.75693	0.24307

[1] Monday through Friday (MOVES dayTypeID = 5).
[2] Saturday and Sunday (MOVES dayTypeID = 2).

Month VMT Fractions by TxDOT District

Month	San Antonio
January	0.07995
February	0.08400
March	0.08655
April	0.08636
May	0.08304
June	0.08504
July	0.08313
August	0.08476
September	0.08088
October	0.08290
November	0.08198
December	0.08141

Hour VMT Fractions by TxDOT District

Hour	San Antonio	
	Week Day[1]	Weekend Day[2]
1	0.009046	0.020744
2	0.006052	0.013851
3	0.005417	0.012773
4	0.005275	0.008486
5	0.008313	0.007933
6	0.019914	0.011579
7	0.051458	0.019319
8	0.072902	0.027542
9	0.060562	0.036477
10	0.049140	0.047078
11	0.048115	0.056063
12	0.051817	0.063120
13	0.054169	0.069206
14	0.056064	0.071056
15	0.059811	0.071275
16	0.068990	0.070595
17	0.078896	0.069024
18	0.081979	0.067156
19	0.062597	0.062895
20	0.043886	0.053122
21	0.034647	0.043948
22	0.030372	0.039203
23	0.024022	0.033159
24	0.016556	0.024396

[1] Monday through Friday (MOVES dayTypeID = 5).
[2] Saturday and Sunday (MOVES dayTypeID = 2).